State of Delaware Final Report: Ozone and $PM_{2.5}$ Observations and Forecasts in 2025

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SPHEROS ENVIRONMENTAL

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State of Delaware Final Report: Ozone and $PM_{2.5}$ Observations and Forecasts in 2025

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Key Findings

- Air quality in Delaware during summer 2025 showed a slight improvement compared with conditions observed in 2024 and was much improved compared with summer 2023, due in large part to the reduced influence of long-range smoke transport.
- Between May and September, ground-level ozone levels in Delaware were in the Good Air Quality Index (AQI) category on 76% of days, the Moderate category on 21% of days, and the Unhealthy for Sensitive Groups (USG) category on 3% of days.
- Between May and September, $PM_{2.5}$ AQI levels in Delaware were in the Good category on 69% of days, the Moderate category on 29% of days, the USG category on 1% of days, and the Unhealthy category on 1% of days. All historical $PM_{2.5}$ AQI comparisons in this document are based on the AQI thresholds that were updated by EPA in February 2024.
- Smoke continued to be a contributing factor to poor air quality on select days. From May through September, 43 out of the 62 days with Moderate-or-higher AQI levels had smoke analyzed over the state. However, the percent of days with Moderate-or-higher ozone AQI levels that had analyzed smoke in summer 2025 was at its lowest levels since summer 2020.
- The most polluted month of the summer forecast season was June, when 18 days recorded Moderate-or-higher AQI levels. Six of the seven days with National Ambient Air Quality Standards (NAAQS) exceedances this summer occurred in June, with ozone being the primary pollutant on four of those days and $PM_{2.5}$ the primary pollutant on two days. Smoke was likely a major factor on all of those days.
- Consistent with 2024, to account for the threat of smoke and its influence on both ozone and $PM_{2.5}$ in Delaware, Spheros forecasters produced $PM_{2.5}$ forecasts alongside the ozone forecasts throughout the entire 2025 forecasting season.
- At the Good-to-Moderate threshold, next-day ozone forecasts were correct 75% of the time during summer 2025, with a probability of detection (POD) of 84% and a false alarm rate (FAR) of 52%. The average ozone forecast bias was +4.9 ppb, with a mean absolute error (MAE) of 7.4 ppb.
- At the Good-to-Moderate threshold, next-day $PM_{2.5}$ forecasts were correct 78% of the time, with a POD of 79% and an FAR of 39%. The average $PM_{2.5}$ forecast bias was +1.3 $\mu g/m^3$, with an MAE of 3.5 $\mu g/m^3$.
- Looking ahead to the 2026 ozone season, Spheros meteorologists predict above-normal temperatures in Delaware during the peak of ozone season from June through August, which may increase ozone formation.

- However, the effects on ozone levels from above-normal temperatures during summer 2026 may be offset by effects from increased precipitation and the associated cloud cover.
- Canadian smoke impacts may increase in summer 2026 due to potential long-term drought across Canada. Additionally, northwesterly mid-level winds may transport smoke into the Mid-Atlantic, which may increase $PM_{2.5}$ and ozone precursors in the region.
- Considering the potential for above-average temperatures and rainfall, combined with increased potential for smoke transport into the Mid-Atlantic, ozone AQI levels are forecast to be near-to-above average, while $PM_{2.5}$ AQI levels are forecast to be above average across Delaware during summer 2026.

1. Air Quality Climatology 2020-2024

For the state of Delaware, the summer air quality forecast season begins on May 1 and ends on September 30, when daily ozone and fine particle ($PM_{2.5}$) forecasts are issued by Spheros. Forecasts are provided seven days a week, covering air quality conditions for the next day and following two days.

Prior to the start of Delaware's summer air quality forecast season, Spheros meteorologists review the observed ozone and $PM_{2.5}$ AQI values from regulatory monitoring sites across the state (**Figure 1**) from previous years. During this review process, climatologies of AQI levels are created using the past five years of observed ozone and $PM_{2.5}$ data. These climatologies assist Spheros meteorologists in identifying patterns and trends in Delaware's air quality, which support forecast decision-making.

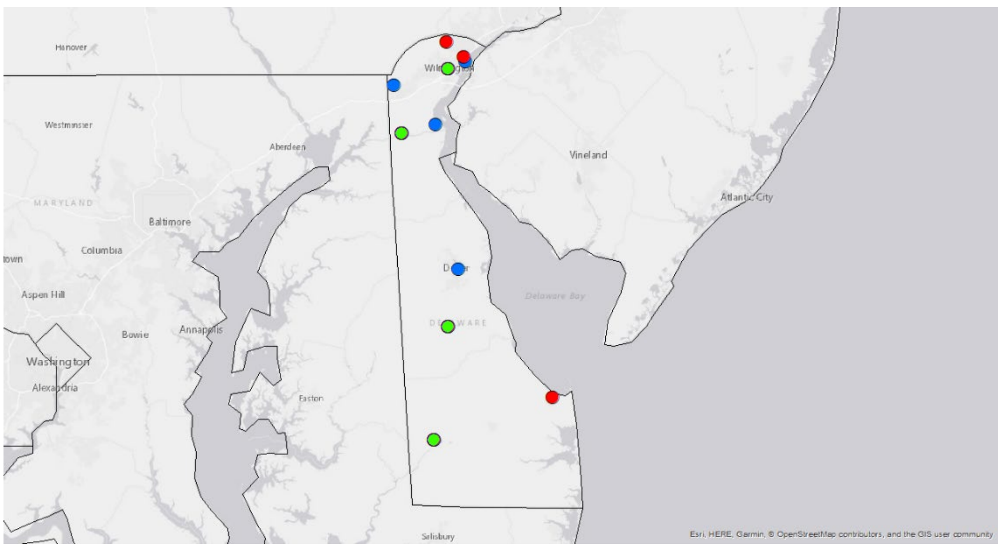

Figure 1. Active ozone and $PM_{2.5}$ monitoring sites in the state of Delaware. Red dots indicate sites that monitor ozone, blue dots indicate sites that monitor $PM_{2.5}$, and green dots indicate sites that monitor both ozone and $PM_{2.5}$.

The following sections contain the AQI climatologies for ozone and $PM_{2.5}$ for the 2020–2024 period. Spheros meteorologists also provide the monthly and daily distributions of past AQI values and highlight the frequency of multiday, high-pollution events that record AQI levels over 100, which corresponds to a National Ambient Air Quality Standards (NAAQS) exceedance.

1.1 Climatology of Ozone

Ground-level ozone formation depends on a variety of meteorological factors; the primary catalysts of ozone are sunlight and warm surface air temperatures. During the spring, longer days and warming temperatures increase ozone production. This pattern is reflected in **Figure 2**: days with Moderate-or-higher ozone AQI levels become more frequent from March through July. By August and September, the gradual seasonal reduction in sunlight and temperatures results in Good ozone AQI levels on most days.

Due to the long-term reductions in regional emissions[1], AQI levels for ozone in Delaware are generally in the Good category (≤ 50 AQI) for most days during the year. Based on the historical data shown in Figure 2, Good ozone AQI levels were observed on 85% of days. During the summer air quality forecast period (**Figure 3**), 71% of days between May and September were characterized by Good AQI levels for ozone.

While Moderate-or-higher ozone AQI values have occurred as early as March and as late as November, these days are most frequent during June and July, when surface temperatures and sunlight reach their seasonal maxima. These meteorological conditions, combined with local and regional emissions, result in enhanced ground-level ozone development in Delaware.

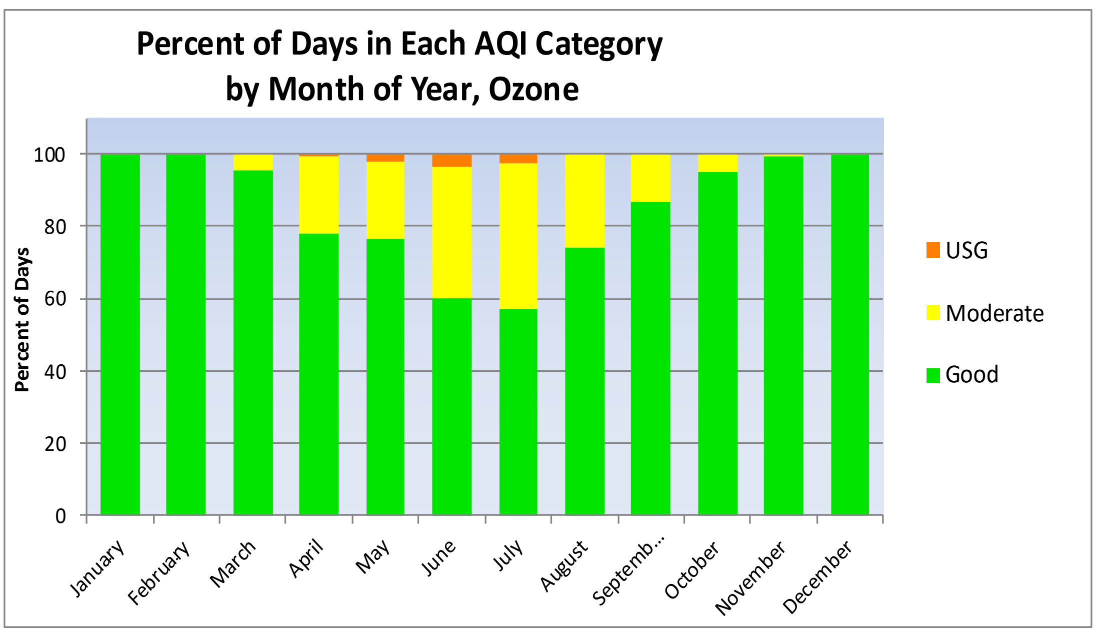

Figure 2. Percentage of days falling in each AQI category each month for ozone for 2020–2024.

[1] EPA Air Quality Trends report: https://gispub.epa.gov/air/trendsreport/2025/#air_trends

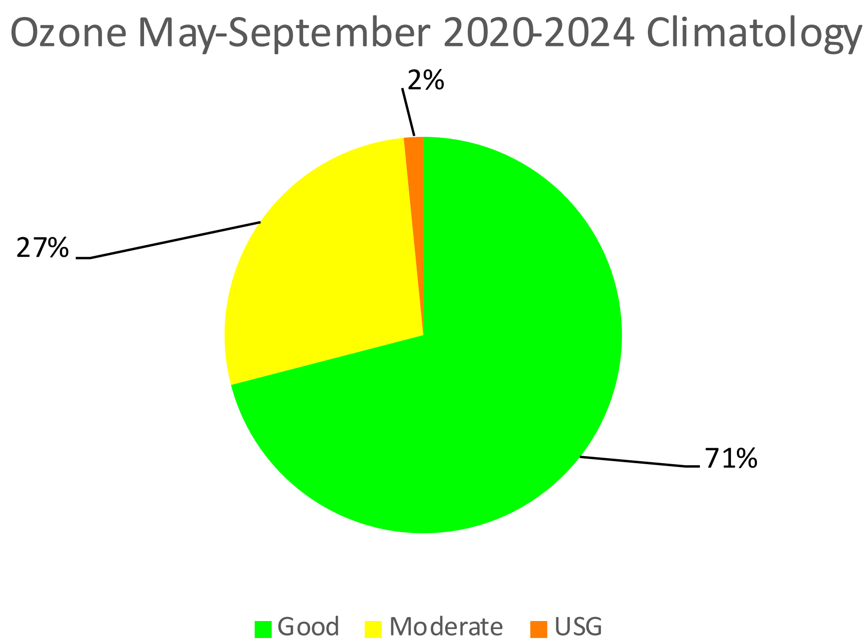

Figure 3. Percent of days with daily ozone AQI levels in each category during the May–September period from 2020–2024.

While infrequent, ozone AQI values in the USG category do occur in the First State. During the five-year period from 2020–2024, USG ozone AQI levels were most frequent in June and July, with other days with USG ozone AQI levels occurring in April and May. Overall, days with USG ozone AQI levels accounted for nearly 2% of all days during the summer air quality forecasting season.

To determine local daily ozone patterns, Spheros meteorologists also produced a climatology of ozone AQI levels based on the day of the week. This information allows Spheros meteorologists to identify which day(s) of the week are prone to Moderate-or-higher ozone AQI levels; such trends can then be related to daily driving patterns or industrial activity that can affect local air quality.

From 2020–2024, Moderate-or-higher ozone AQI levels were most prevalent on Wednesdays (**Figure 4**) and generally occurred at a similar frequency on Tuesdays, Thursdays, and Fridays. While industrial and traffic activity decreases during the weekends, it is likely that pollutant carryover from Fridays contributed to Moderate-or-higher ozone AQI levels on Saturdays in Delaware. Sundays and Mondays were characterized by the fewest occurrences of Moderate-or-higher ozone AQI levels. This finding can be related to the reduction in industrial emissions and traffic over the weekends, as well as low pollutant carryover from Sundays into Mondays.

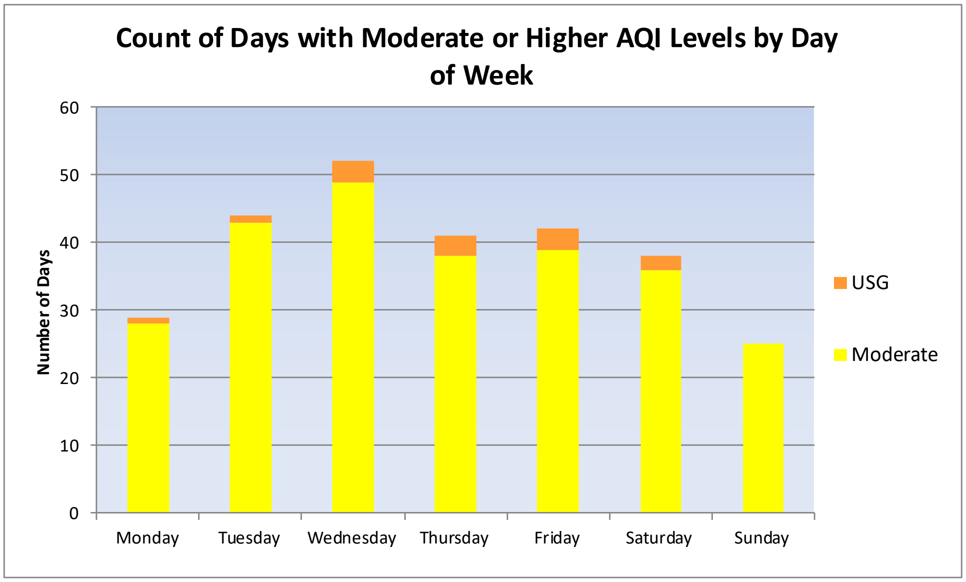

Figure 4. Number of days with Moderate-or-higher ozone AQI levels in Delaware by day of week for 2020–2024.

USG ozone events in Delaware are usually isolated occurrences; periods with multiple consecutive days of USG ozone AQI levels are rare. From 2020 to 2024, there were 13 days with USG ozone AQI levels recorded. Of these days, nine NAAQS exceedances were on a single-day basis (**Figure 5**). USG ozone AQI levels were recorded on back-to-back days in only two instances.

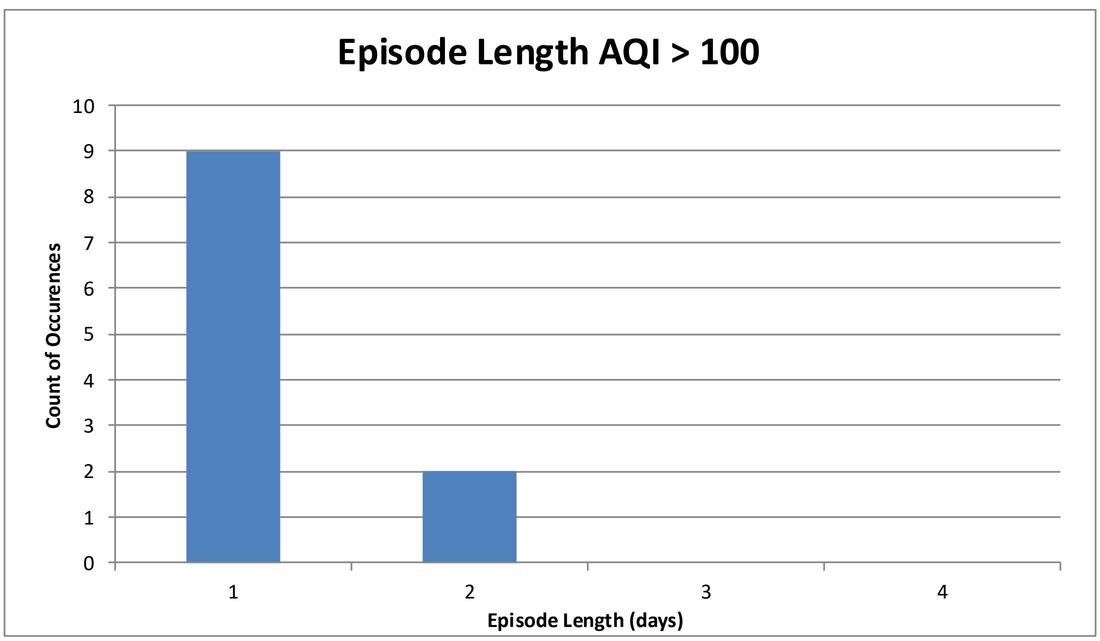

Figure 5. Number of occurrences of multiday ozone AQI levels in the USG category or higher in Delaware based on 2020–2024 data.

1.2 Climatology of $PM_{2.5}$

Along with ground-level ozone, $PM_{2.5}$ impacts air quality in Delaware throughout the year. $PM_{2.5}$ sources that affect Delaware's air quality include local residential wood burning, industrial emissions, and long-range transport of wildfire smoke. In addition to daily ozone forecasts, $PM_{2.5}$ forecasts were issued by Spheros meteorologists from May through September 2025. To assist with daily $PM_{2.5}$ forecasting operations, monthly and seasonal climatologies of $PM_{2.5}$ AQI levels were developed using 2020–2024 observed $PM_{2.5}$ AQI data in Delaware.

Based on the 2020–2024 climatology, $PM_{2.5}$ AQI levels were Good on over 56% of days (**Figure 6**). On average, Moderate-or-higher AQI levels were most frequent during two periods of the year. The first period was November through February, when smoke from residential wood burning occurs and cold temperatures generate overnight inversions that trap smoke and other emissions near the ground. The second period was June through August, when long-range transport of wildfire smoke into the First State was more likely to occur.

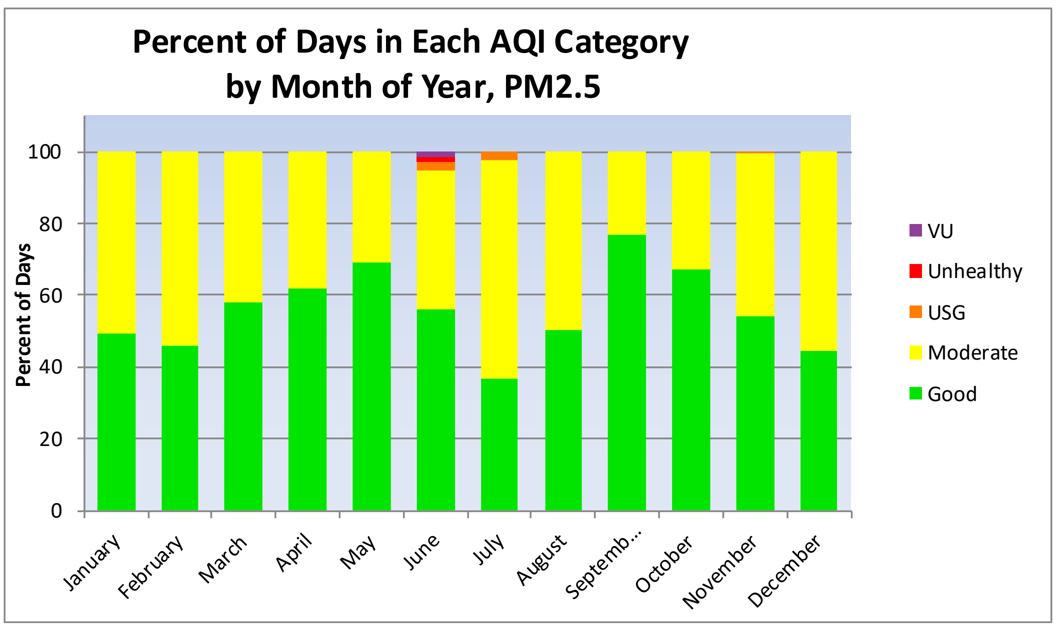

Figure 6. Monthly distribution of days falling in each AQI category based on 2020–2024 $PM_{2.5}$ data.

For the May through September period (**Figure 7**), 58% of days between May and September were characterized by Good AQI levels for $PM_{2.5}$. Moderate $PM_{2.5}$ AQI levels occurred on 41% of days, and USG-or-higher $PM_{2.5}$ AQI levels were recorded on roughly 1% of days. As has been shown with previous $PM_{2.5}$ climatologies, the month of July exhibited the highest percentage of days (i.e., 63%) with Moderate-or-higher $PM_{2.5}$ AQI levels from 2020–2024. Tuesdays, Wednesdays, and Thursdays were the days of the week most likely to exhibit Moderate-or-higher AQI levels for $PM_{2.5}$ during the

2020–2024 period (**Figure 8**). Most other days of the week exhibited a similar number of Moderate-or-higher $PM_{2.5}$ AQI levels, with Saturdays recording a lower frequency of such AQI levels.

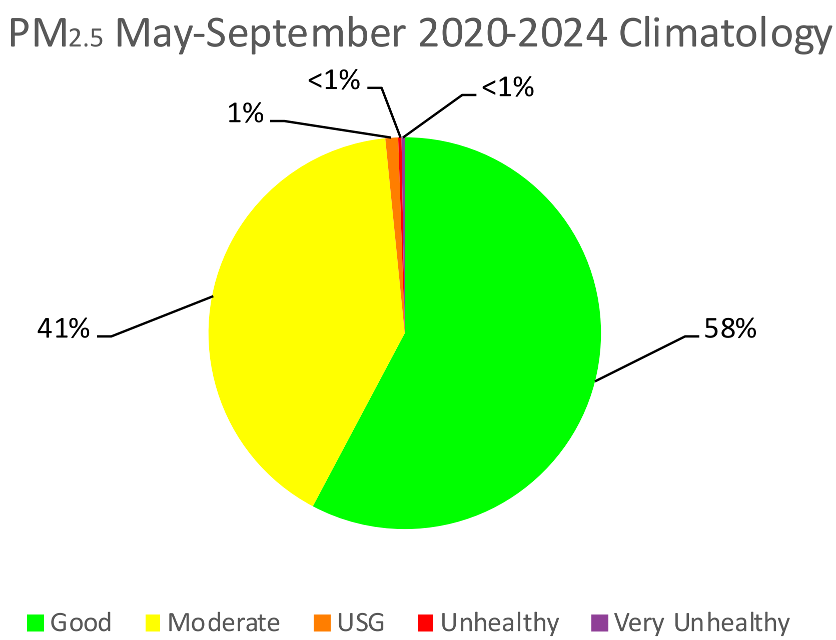

Figure 7. Percent of days with daily $PM_{2.5}$ AQI levels falling in each category during the May–September period from 2020 to 2024.

USG-or-higher $PM_{2.5}$ AQI levels were recorded in Delaware 13 times during the 2020–2024 period. Ten of the days with USG-or-higher AQI levels for $PM_{2.5}$ were recorded in June and July 2023, when long-range transport of wildfire smoke from Canada degraded air quality across a large portion of the eastern United States, including the Mid-Atlantic region.

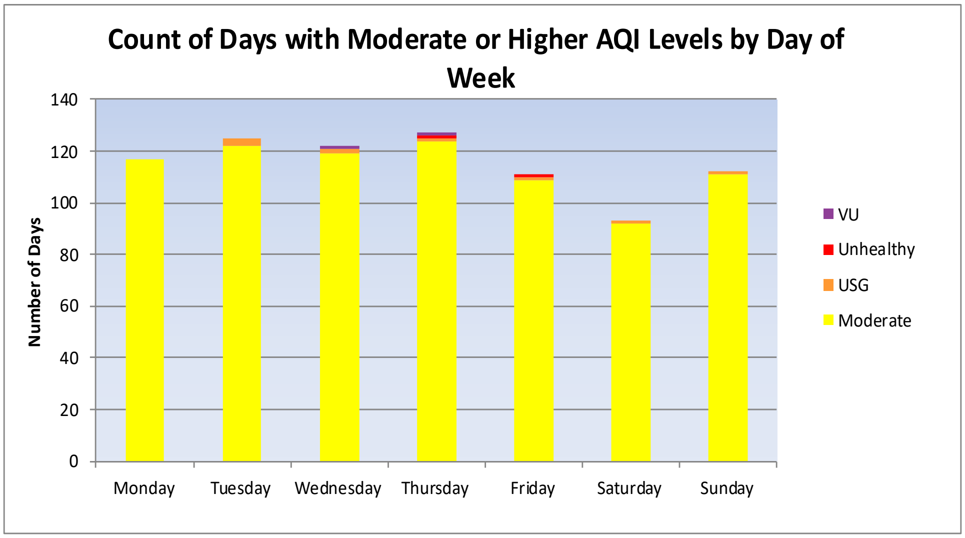

Figure 8. Number of days with Moderate-or-higher $PM_{2.5}$ AQI levels in Delaware by day of week based on 2020–2024 data.

Spheros meteorologists examined how many of these particle pollution events were single-day occurrences or multiday episodes. The data over the last five years indicate that while most days with $PM_{2.5}$ AQI levels over 100 were single-day events, there were also several multiday periods (Figure 9). On one occasion, $PM_{2.5}$ AQI exceeded 100 on two straight days (i.e., July 20 and 21, 2021). During summer 2023, there were two separate four-day periods of USG-or-higher $PM_{2.5}$ AQI levels (i.e., June 6–9 and June 28–July 1), driven by long-range transport of dense smoke from Canadian wildfires into Delaware.

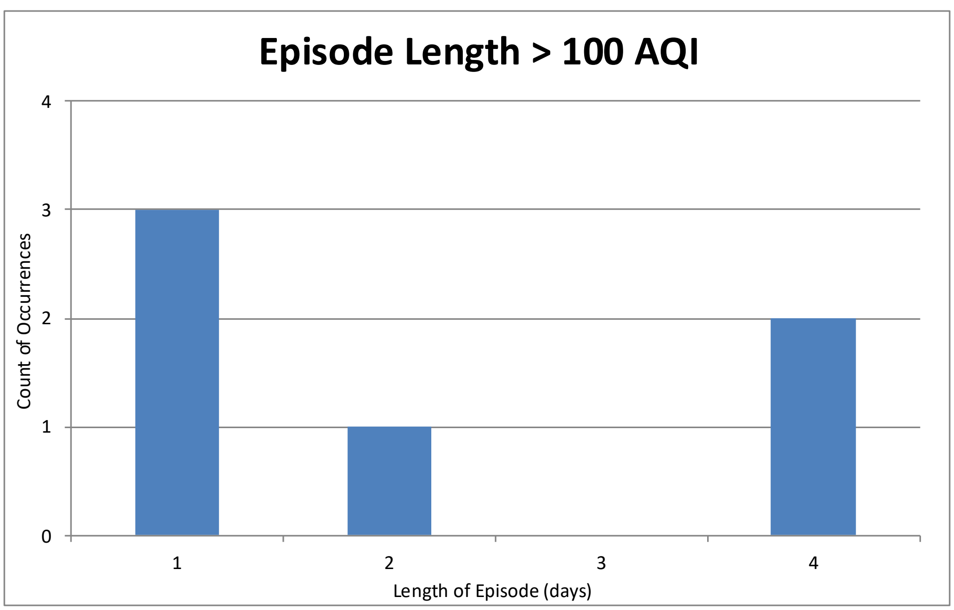

Figure 9. Number of occurrences of multiday spans of $PM_{2.5}$ AQI levels falling in the USG category or higher in Delaware based on 2020–2024 data.

2. Air Quality and Meteorological Observations in 2025

2.1 Summer 2025 Daily Maximum AQI Observations

The summer air quality forecast season for the state of Delaware covers a total of 153 days. **Figure 10** provides a time series of observed maximum AQI values across ozone and $PM_{2.5}$ during the 2025 summer forecast season, and **Figure 11** shows the percentage of days falling in each AQI category for the 2023, 2024, and 2025 summer forecast seasons. Based on data from air quality monitoring sites shown in Figure 1, daily maximum AQI levels for May through September 2025 were Good on 91 days, Moderate on 55 days, USG on 6 days, and Unhealthy on 1 day. Compared with the previous two summers, the number of Moderate-or-higher AQI days observed in summer 2025 decreased.

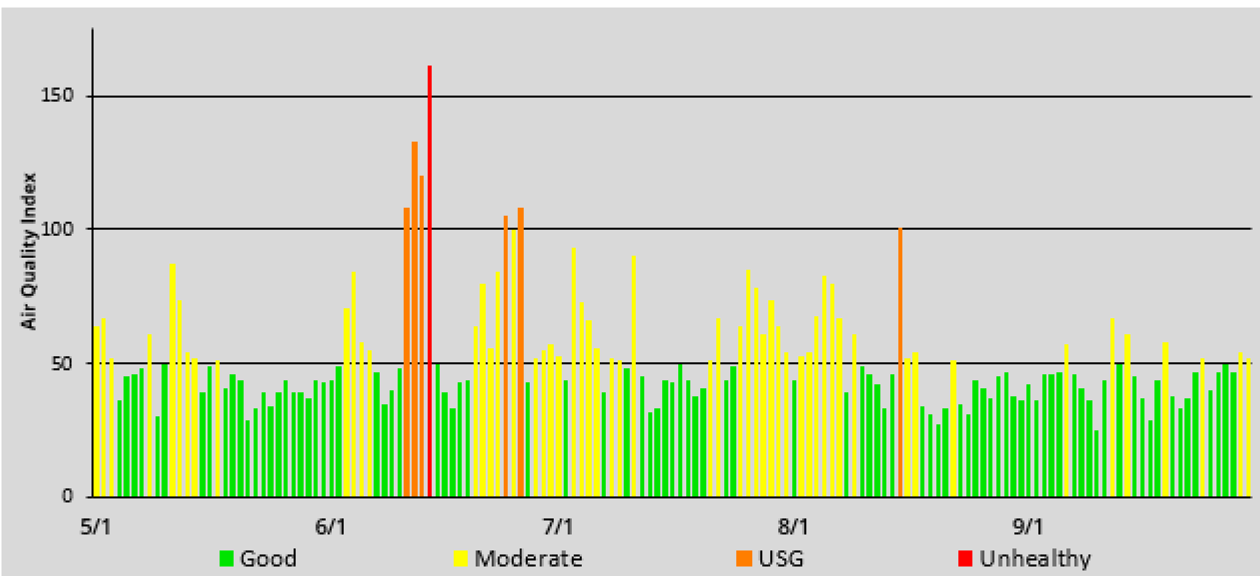

Figure 10. Daily maximum observed AQI values (including both ozone and $PM_{2.5}$) during the summer 2025 forecast season in Delaware.

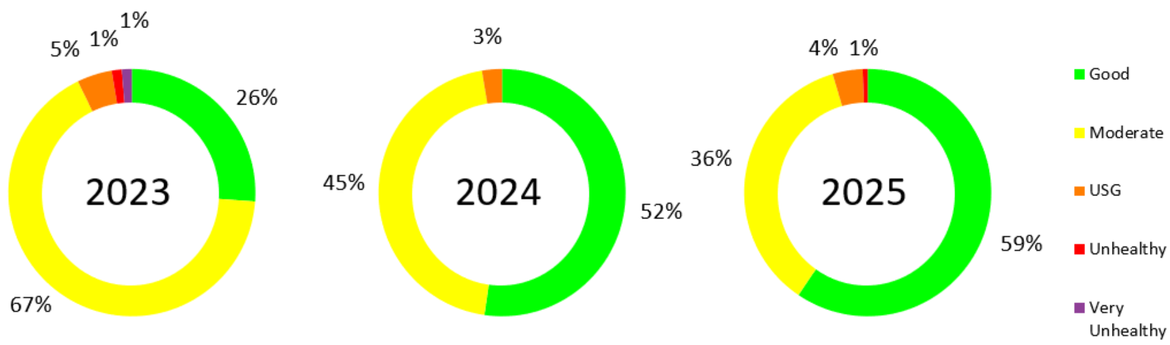

Figure 11. Percent of days with daily maximum AQI levels (including both ozone and $PM_{2.5}$) in each category during the summer 2023, 2024, and 2025 forecast seasons in Delaware.

Table 1 lists the monthly breakdown of daily maximum AQI values for the 2025 summer forecasting season. June 2025 was the most polluted month of the season, with 18 Moderate-or-higher AQI days recorded in Delaware. In all, 60% of June 2025 days featured AQI levels above 50, which was similar to June 2024 but better than June 2023.

Six of the seven days with NAAQS exceedances in summer 2025 occurred in June, with ozone being the primary pollutant on four of those days and $PM_{2.5}$ being the primary pollutant on two days. Overall, 13% of June 2025 days featured ozone NAAQS exceedances. This percentage is anomalous compared with the 2020–2024 ozone climatology shown in Figure 2, which shows USG ozone AQI days occurring on only 3% of June days in Delaware. For $PM_{2.5}$, USG-or-higher AQI days in June 2025 occurred 6% of the time, which is marginally more than the percentage of days recorded in the 2020–2024 $PM_{2.5}$ June climatology (5%). More details on the NAAQS exceedances in June 2025 can be found in Section 3.

September was the cleanest month of summer 2025, with Good air quality occurring more than 75% of the time. The prevalence of Good AQI levels can be partially attributed to the seasonal reduction in sunlight and temperatures limiting ozone production.

Table 1. Number of days with daily maximum AQI levels (including both ozone and $PM_{2.5}$) by month during the summer 2025 forecast season in Delaware.

Month	Good	Moderate	USG	Unhealthy
May	22	9	0	0
June	12	12	5	1
July	14	17	0	0
August	20	10	1	0
September	23	7	0	0

2.2 Summer 2025 Daily Ozone AQI Observations

Ground-level ozone observations in the state of Delaware were in the Good AQI category on 76% of days during the May–September 2025 period (**Figure 12**). Moderate AQI levels were recorded on 21% of days, and USG AQI levels occurred on 3% of days. While there were more days with USG ozone AQI levels in summer 2025 versus the previous two summers, days with Good ozone AQI levels in summer 2025 were more frequent than in summer 2023 and summer 2024.

For May–September 2025, Moderate-or-higher ozone AQI days occurred 24% of the time. This percentage can be contrasted with the historical record: the 2020–2024 ozone climatology shown in Figure 3 indicates that 29% of May–September days exhibited Moderate-or-higher ozone AQI levels. In May and June 2025, the frequency of days with Moderate-or-higher ozone AQI levels was similar to the 2020–2024 climatology. However, July, August, and September ozone AQI observations this forecast season featured fewer days with Moderate-or-higher ozone AQI levels compared with the 2020–2024 climatology.

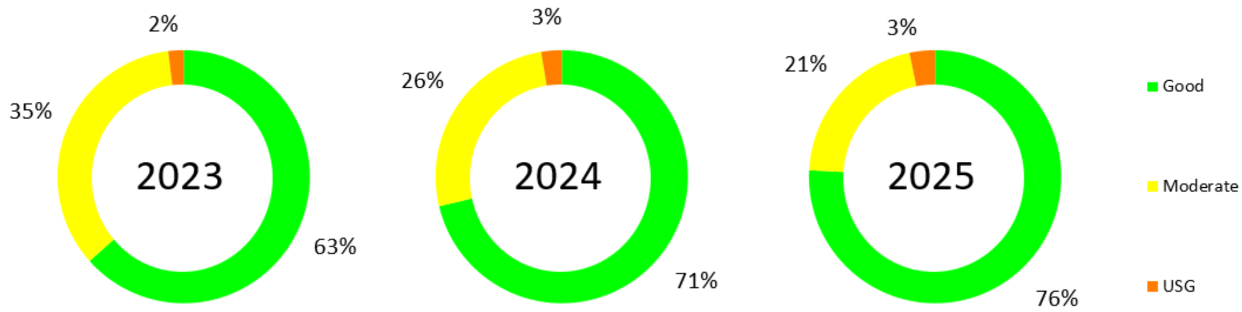

Figure 12. Percent of days with daily maximum ozone AQI levels falling in each AQI category for the 2023, 2024, and 2025 Delaware summer forecast seasons.

Figure 13 shows a site-by-site comparison of ozone AQI levels for the 2025 summer forecast season, and **Table 2** lists a percentage breakdown of AQI categories for each ozone monitoring site in the First State. All but one ozone monitoring site recorded at least one day with USG ozone AQI levels, including Lewes (LEW). Typically, the ocean's influence in Lewes leads to cooler temperatures, stronger winds, and better air quality there compared with other Delaware ozone sites. However, AQI levels on June 24 reached 105, marking Lewes' first day with USG ozone AQI levels in seven years (i.e., since July 11, 2018). More information on the June 24 ozone exceedance at Lewes can be found in Section 3.

Moderate-or-higher ozone AQI levels were most prevalent at the Lums (LUM) monitoring station, where 17% of days featured AQI levels greater than 50. The Lums site is located near major highways and in between metropolitan areas, which makes it prone to local and regional emissions sources.

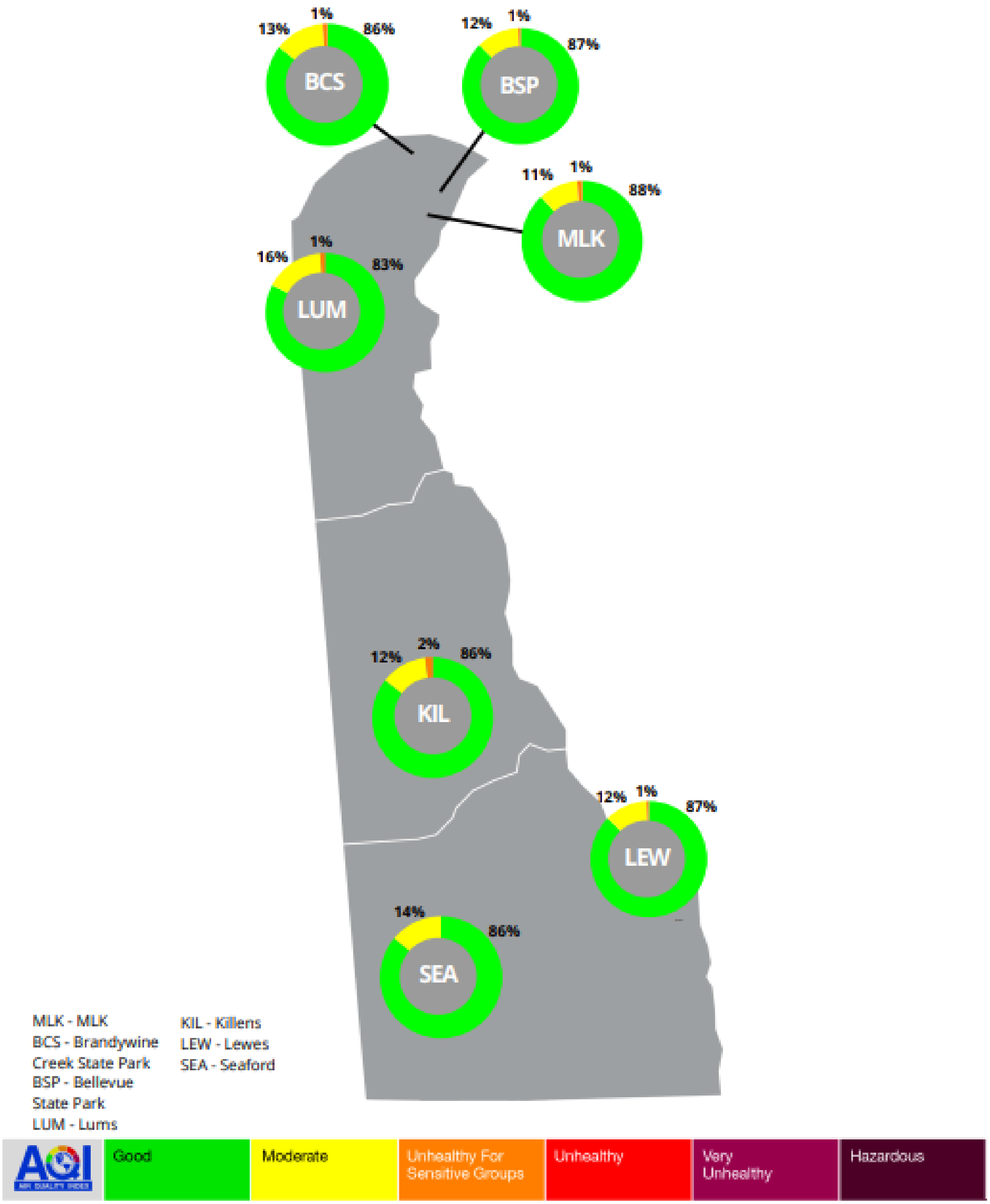

Figure 13. Percentage of days with daily maximum ozone AQI levels falling in each AQI category during the 2025 summer forecast season.

Table 2. Percent of days falling in each AQI category for ozone AQI levels by site for summer 2025. Station abbreviations from Figure 13 appear in parentheses.

Monitoring Site	Good	Moderate	USG
MLK Boulevard (MLK)	88%	11%	1%
Bellevue State Park (BSP)	87%	12%	1%
Brandywine Creek State Park (BCS)	86%	13%	1%
Lums (LUM)	83%	16%	1%
Killens (KIL)	86%	12%	2%
Seaford (SEA)	86%	14%	0%
Lewes (LEW)	87%	12%	1%

Since 2000, the annual number of days with ozone levels above the current NAAQS (i.e., 70 ppb) has gradually declined. Since 2013, USG-or-higher ozone AQI levels have been infrequent across Delaware (**Figure 14**). This summer forecast season marks the sixth time since 2013 that each Delaware county had at least one day with USG-or-higher ozone AQI levels.

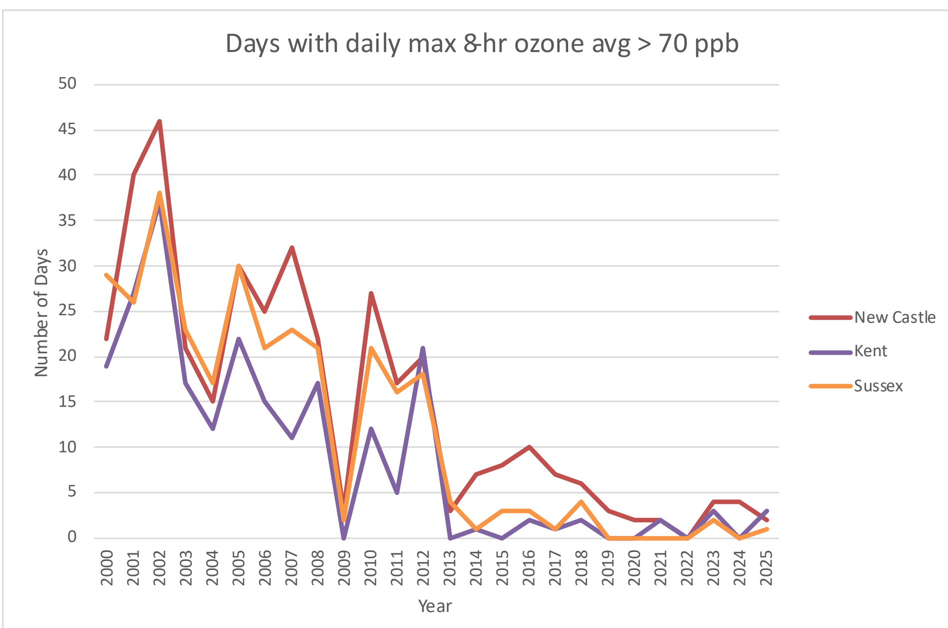

Figure 14. Year-to-year frequency of ozone exceedances by county. Source: U.S. EPA Air (**https://www.epa.gov/outdoor-air-quality-data**).

2.3 Summer 2025 Daily $PM_{2.5}$ AQI Observations

During the May–September 2025 period, daily $PM_{2.5}$ AQI levels across Delaware were in the Good category 69% of the time, the Moderate category 29% of the time, the USG category 1% of the time, and the Unhealthy category 1% of the time (**Figure 15**). The number of days with Good $PM_{2.5}$ AQI levels increased to 106 days in summer 2025, compared with 97 days the previous summer; the number of days with Moderate $PM_{2.5}$ AQI levels decreased from 37% in summer 2024 to 29% in summer 2025. However, USG-or-higher $PM_{2.5}$ AQI levels in summer 2025 increased when compared with summer 2024.

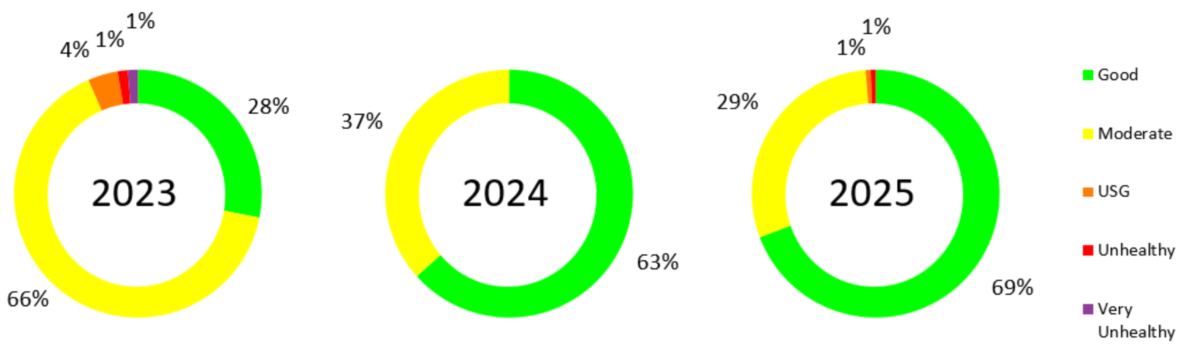

Figure 15. Percent of days with daily maximum $PM_{2.5}$ AQI levels in each AQI category for the 2023, 2024, and 2025 Delaware summer forecast seasons.

Summer 2025 $PM_{2.5}$ AQI levels were better than the 2020–2024 $PM_{2.5}$ climatology shown in Figure 7. During the last five years, $PM_{2.5}$ AQI values in Delaware from May through September were, on average, Moderate or higher on 42% of days; $PM_{2.5}$ AQI levels recorded across Delaware during the same period in 2025 were Moderate or higher on only 31% of days.

Figure 16 provides a site-by-site comparison of $PM_{2.5}$ AQI values in the First State, and **Table 3** lists a percentage breakdown of AQI categories for each $PM_{2.5}$ monitoring site. Between 72 and 88% of the time, Good air quality was present across all sites. Unhealthy $PM_{2.5}$ AQI levels were recorded at the MLK Boulevard (MLK) and River Road Park (RIV) monitoring sites over the summer. At the Newark (NEW) site, 28% of days featured Moderate-or-higher $PM_{2.5}$ AQI levels, which was the most of any site during the forecasting season. Based on $PM_{2.5}$ data, the cleanest site during summer 2025 was Seaford (SEA), where Good $PM_{2.5}$ AQI levels occurred nearly 90% of the time.

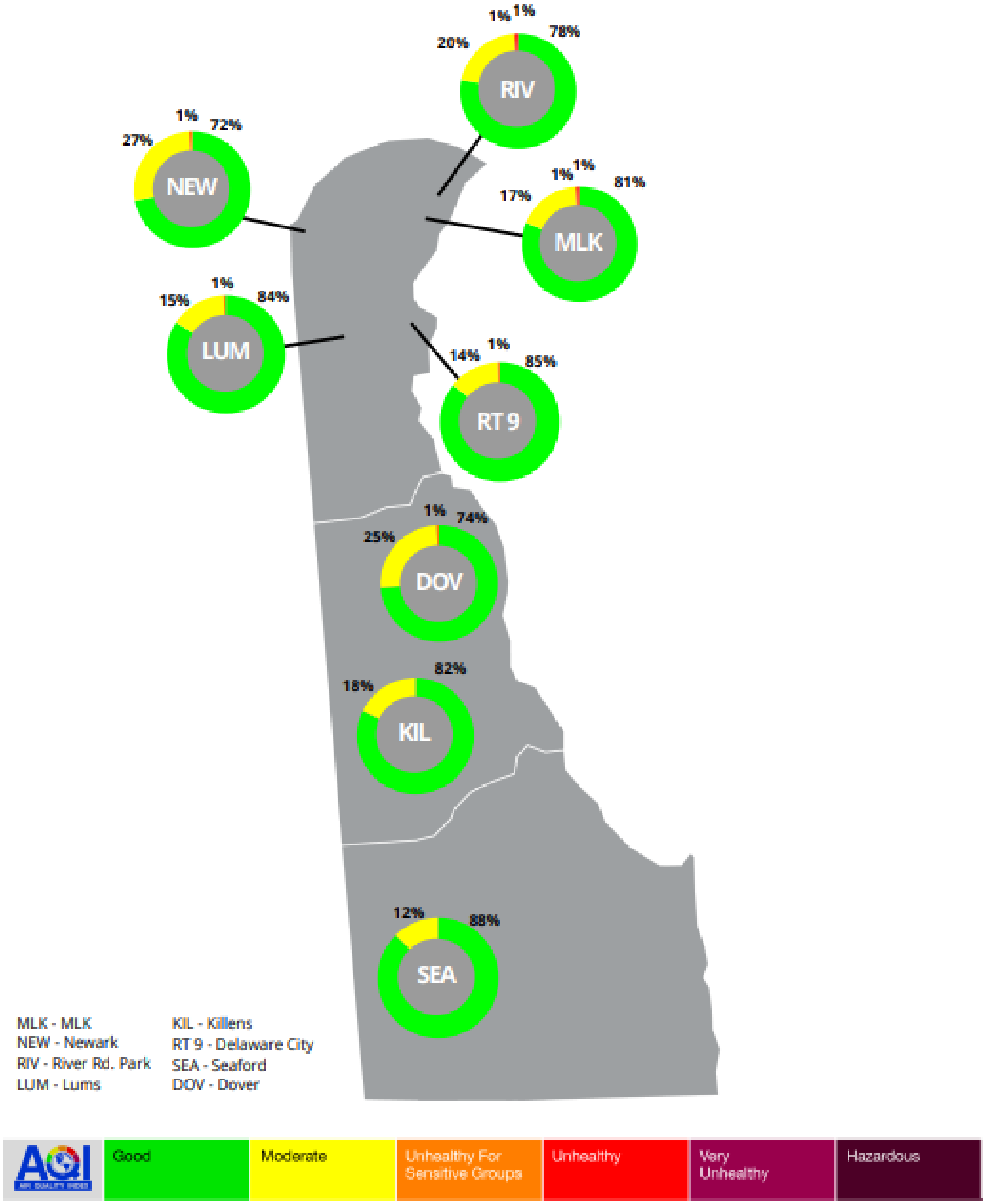

Figure 16. Percentage of days with daily maximum $PM_{2.5}$ AQI levels falling in each AQI category during the 2025 summer forecast season.

Table 3. Percentage of days with daily maximum AQI levels falling in each AQI category for $PM_{2.5}$ by site for summer 2025. Station abbreviations from Figure 16 appear in parentheses.

Monitoring Site	Good	Moderate	USG	Unhealthy
MLK Boulevard (MLK)	81%	17%	1%	1%
River Rd. Park (RIV)	78%	20%	1%	1%
Delaware City (RT 9)	85%	14%	1%	0%
Lums (LUM)	84%	15%	1%	0%
Killens (KIL)	82%	18%	0%	0%
Seaford (SEA)	88%	12%	0%	0%
Dover (DOV)	74%	25%	1%	0%
Newark (NEW)	72%	27%	1%	0%

2.4 Smoke Impacts on Delaware’s Air Quality During Summer 2025

Summer air quality in Delaware can be impacted by the long-range transport of wildfire smoke. Wildfire smoke contains a variety of pollutants, including $PM_{2.5}$, volatile organic compounds (VOCs), and numerous other pollutants. Each of these air compounds can add to existing $PM_{2.5}$ concentrations from local sources, as well as alter ozone chemistry to increase ozone formation. Given the importance that smoke has on Delaware's air quality, Spheros meteorologists examined satellite data from the National Oceanic and Atmospheric Administration (NOAA) to determine the presence of smoke in the First State for summer 2025 and to compare this season’s smoke conditions with those during previous forecast seasons.

Smoke days in Delaware were assessed using NOAA Hazard Mapping System (HMS) data, with a “smoke day” being counted when an HMS smoke plume was analyzed over portions or the entire state of Delaware. In summer 2025, there were 82 smoke days in Delaware based on NOAA HMS data. As shown in **Figure 17**, the number of smoke days for summer 2025 was the lowest since summer 2020.

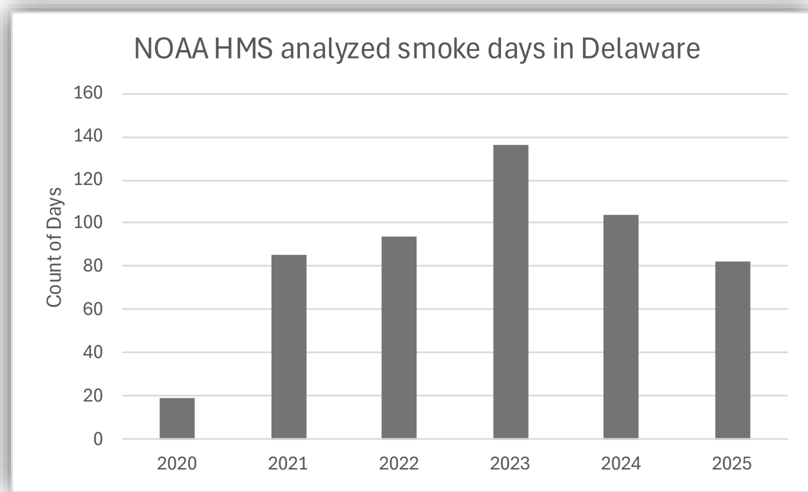

Figure 17. Number of days with analyzed smoke in Delaware, May through September, based on NOAA HMS data.

Using the maximum AQI levels across both ozone and $PM_{2.5}$, 43 out of the 62 days with Moderate-or-higher AQI levels during summer 2025 (i.e., 69% of days) had smoke analyzed over the state. For ozone only, NOAA satellites analyzed smoke over Delaware on 26 out of the 37 days with Moderate-or-higher ozone AQI levels (i.e., 70% of days). In June, smoke was analyzed on all 12 days with Moderate-or-higher ozone AQI levels, which was the highest percentage of any month during summer 2025. Although smoke was analyzed over Delaware on the majority of days with Moderate-or-higher ozone AQI levels during May through September, the percentage of days with Moderate-or-higher ozone AQI levels that had analyzed smoke in summer 2025 was at its lowest levels since summer 2020, as shown in **Figure 18**.

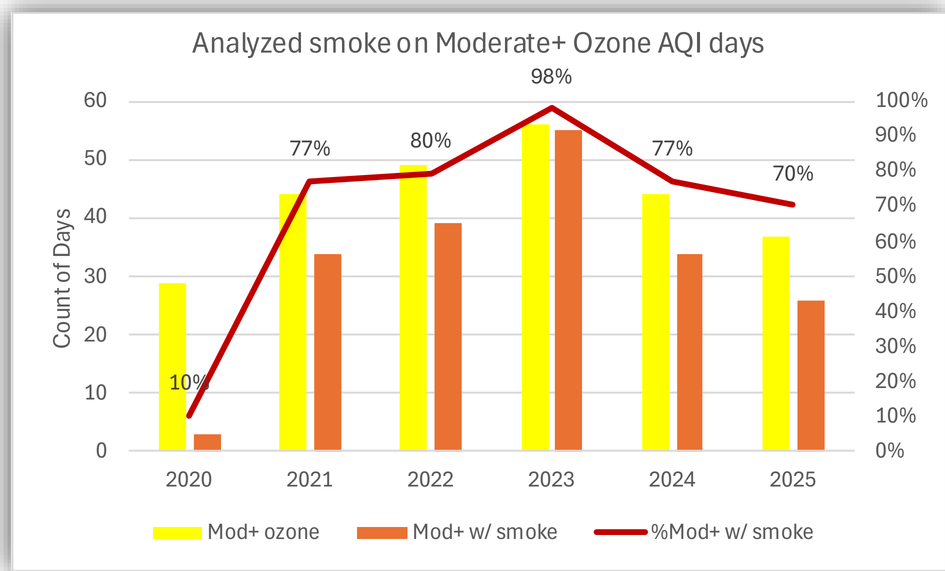

Figure 18. Analyzed smoke on days with Moderate-or-higher ozone AQI levels in Delaware from 2020 to 2025. Yellow bars indicate the number of days with Moderate-or-higher AQI levels; orange bars indicate the number of days with Moderate-or-higher AQI levels *and* smoke. The red line indicates the percentage of days with Moderate-or-higher AQI levels that had smoke.

For $PM_{2.5}$, smoke was analyzed over Delaware on 35 of the 47 days with Moderate-or-higher $PM_{2.5}$ AQI levels (i.e., 74% of days). Similar to the ozone AQI levels shown in Figure 18, analyzed smoke on days with Moderate-or-higher $PM_{2.5}$ AQI levels in summer 2025 was at its lowest level since summer 2020 (Table 4). As in the case for ozone, June featured the highest occurrence of analyzed smoke on days with Moderate-or-higher $PM_{2.5}$ AQI levels. Of the 16 June days with Moderate-or-higher $PM_{2.5}$ AQI levels, NOAA analyzed smoke over Delaware on 15 days.

Table 4. Number of days with smoke detections on days with Moderate-or-higher $PM_{2.5}$ AQI levels in Delaware from 2020–2025.

Year	Number of Days with Moderate+ $PM_{2.5}$ AQI Levels	Number of Days with Moderate+ $PM_{2.5}$ AQI Levels with Smoke	Percent of Days with Moderate+ $PM_{2.5}$ AQI Levels with Smoke
2020	46	5	11%
2021	65	50	77%
2022	47	40	85%
2023	110	106	96%
2024	56	45	80%
2025	47	35	74%

2.5 May–September 2025 Meteorological Review

Prevailing weather conditions can strongly influence air quality and the corresponding observed AQI levels in Delaware throughout the year. During the summer, sunny and hot conditions combine with regional and local emissions to enhance the production of ground-level ozone. Wind patterns can also increase AQI values by either transporting regional pollutants and wildfire smoke into the state, or by allowing pollutants to accumulate over time. On the other hand, cool, cloudy days tend to reduce ozone development, and days with gusty winds can effectively disperse pollutants, transport cleaner air into the state, and keep AQI levels in the Good category. The following section reviews the observed meteorological conditions in Delaware during the 2025 summer air quality forecasting season, based on data from National Weather Service Automated Surface Observation Systems (ASOS) climate sites.

For the May through September 2025 period, average temperatures in the Mid-Atlantic region were generally 0.5–1.0°F warmer than the 1991–2020 long-term average (**Figure 19**). In the state of Delaware, the average temperature for the summer 2025 forecast season varied by meteorological site; at the Wilmington (KILG) ASOS site, temperatures were 1.0°F above normal, while the Georgetown (KGED) ASOS site recorded a seasonal average temperature that was 0.2°F below normal.

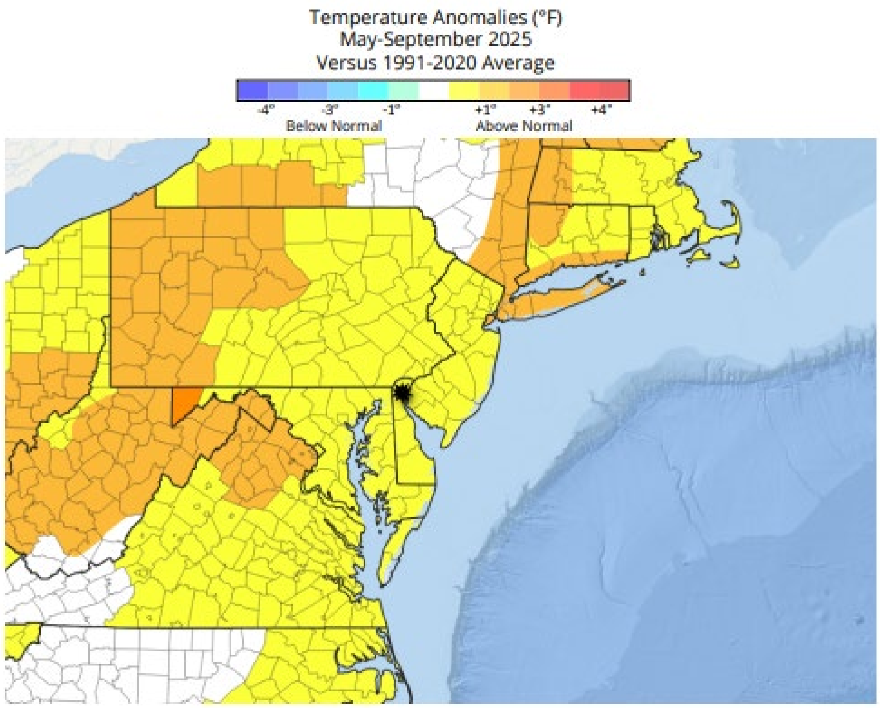

Figure 19. May–September 2025 average temperature anomaly map.

Based on historical weather data, July is the warmest month of the summer forecast season for both KILG and KGED. Summer 2025 was no exception, with both ASOS sites recording their warmest average temperature of the forecast season in July. For July 2025, KILG (**Table 5**) recorded 12 days with temperatures reaching or exceeding 90°F, while KGED (**Table 6**) recorded 13 days at or above the 90°F mark.

Table 5. 2025 monthly meteorological summary for the Wilmington-New Castle Airport (KILG) site.

Wilmington (KILG)	May	June	July	August	September
Average Temperature (°F)	64.5	74.9	80.9	72.6	71.1
Average Temperature Departure from Normal (°F)	+1.0	+2.3	+2.7	-3.2	+2.2
Total Precipitation (inches)	6.73	3.95	6.73	1.40	1.86
Precipitation Departure from Normal (inches)	+3.16	-0.72	+2.32	-2.58	-2.52
Number of Clear Days	12	19	15	17	15
Number of 90°F+ Days	0	8	12	3	1
Average Wind Speed (mph)	8.7	7.1	6.7	7.1	7.0
Average Wind Speed Departure from Normal (mph)	-0.1	-1.0	-0.8	-0.1	-0.7

Table 6. 2025 monthly meteorological summary for the Georgetown (KGED) site.

Georgetown (KGED)	May	June	July	August	September
Average Temperature (°F)	65.6	75.7	80.0	71.6	69.9
Average Temperature Departure from Normal (°F)	+1.1	+2.1	+1.4	-5.1	-0.5
Total Precipitation (inches)	5.35	1.87	9.45	2.23	3.07
Precipitation Departure from Normal (inches)	+1.72	-2.20	+5.31	-1.76	-1.47
Number of Clear Days	13	16	16	20	16
Number of 90°F+ Days	0	13	13	3	3
Average Wind Speed (mph)	7.0	5.8	5.4	5.4	6.1
Average Wind Speed Departure from Normal (mph)	-0.5	-0.7	-0.7	+0.1	0.0

Cumulative rainfall totals for May through September 2025 were near- to above-normal for most of the Mid-Atlantic region (**Figure 20**). In Delaware, KILG recorded 20.67 inches of precipitation during the five-month period, which was 0.34 inches below average. At KGED, 21.97 inches of rainfall was recorded during the same period, which was over 1.50 inches above average.

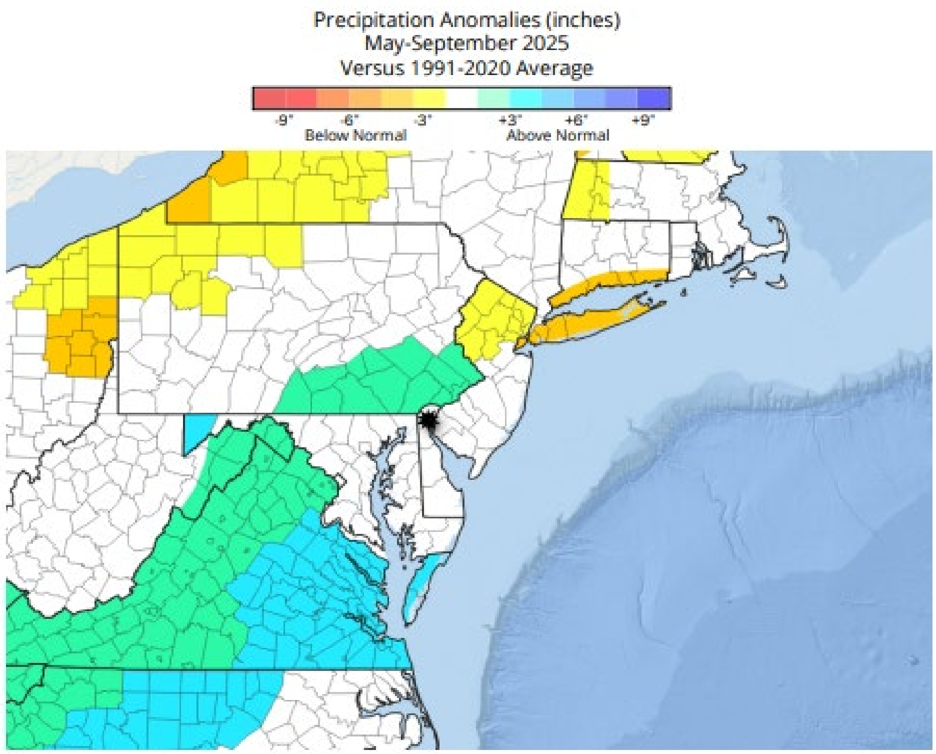

Figure 20. May–September 2025 precipitation anomaly map.

For KILG, both May and July were the wettest months of the summer forecasting season, with each month receiving 6.73 inches of precipitation. In May, a persistent trough of low pressure aloft resulted in anomalously low 500-mb geopotential heights west of the state (**Figure 21**), leading to an active weather pattern and resulting in partly to mostly cloudy skies on 19 of the month's 31 days. Furthermore, 14 days in May recorded measurable precipitation, which was the largest number of May days with measurable rain in three years. These conditions led to KILG's ninth-wettest May on record.

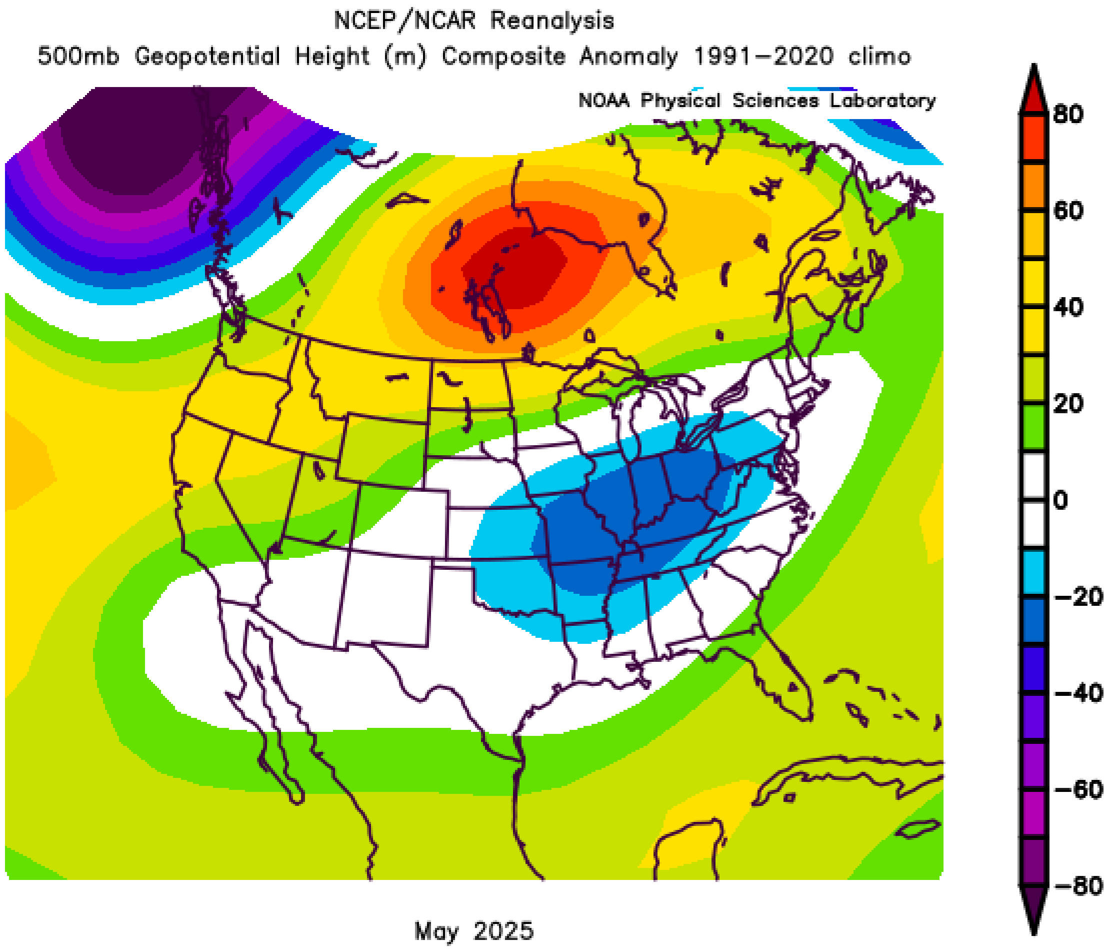

Figure 21. May 2025 500-mb height anomalies. The blue shading indicates the presence of anomalously low pressure aloft, which yielded several May days with partly to mostly cloudy skies and rainfall in Delaware. Source: NOAA.

While July was tied for the wettest month of summer 2025 at KILG, it was also the wettest month of the summer forecasting season at KGED. A west-to-east 250-mb wind pattern near the top of the troposphere (**Figure 22**) directed several frontal boundaries into Delaware during the month, yielding numerous days with measurable rainfall at both locations. For KILG, three days in July recorded at least 1 inch of rainfall, which was the most recorded in July in two years. At KGED, at least 1 inch of rainfall occurred on five days in July 2025, which tied for the second most on record for the site for July. Additionally, the 9.45 inches of rainfall at KGED in July 2025 marked the fourth-wettest July on record.

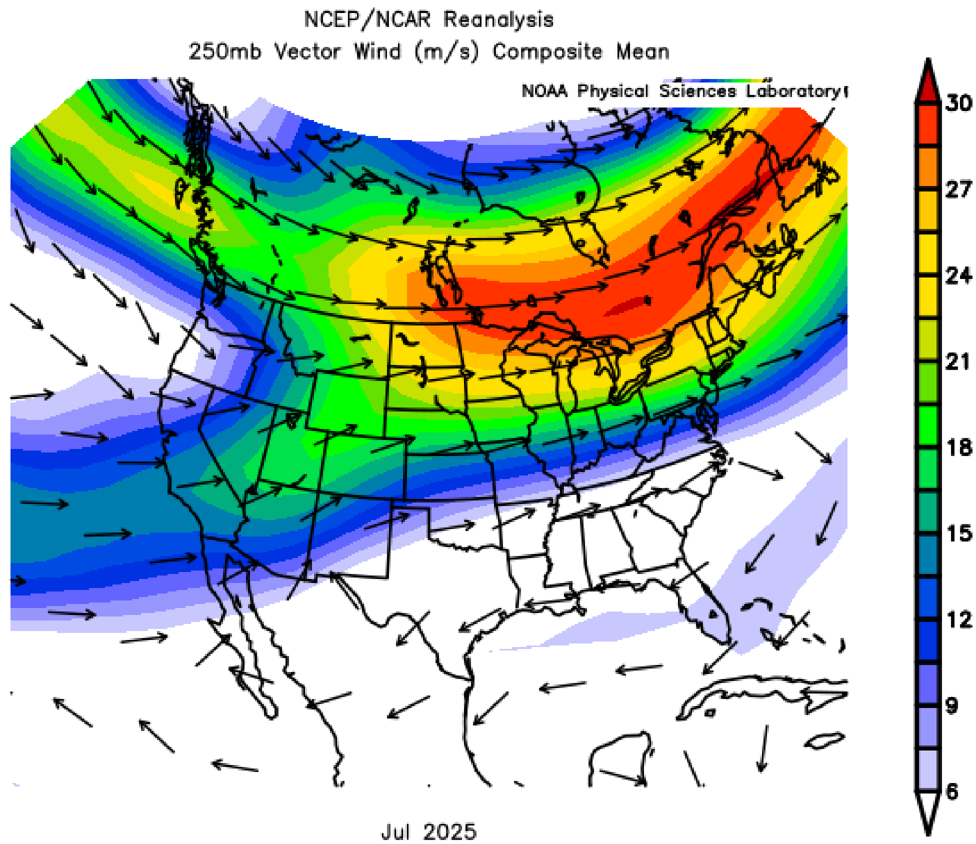

Figure 22. Mean 250-mb wind for July 2025. A west-to-east wind pattern, known as a zonal flow, guided numerous storm systems into Delaware; those storms produced wetter-than-normal conditions for the month. Source: NOAA.

For both $PM_{2.5}$ and ozone, the number of days with Moderate-or-higher AQI levels in June 2025 was the most for any month during the 2025 summer forecast season. Based on the average wind speed anomalies listed in Tables 4 and 5, June featured the lightest winds of the season for KILG (-1.0 mph from normal), while KGED recorded its lowest wind speed anomalies in both June and July (-0.7 mph from normal each month). Although the active July weather pattern shown in Figure 22 aided dispersion, the June weather pattern with lighter winds was conducive to a higher frequency of days with Moderate-or-higher AQI levels for ozone and $PM_{2.5}$. In addition to light surface winds, high pressure aloft was prevalent throughout the month across the Mid-Atlantic region, which inhibited low-level mixing. **Figure 23** shows the surface wind speed anomalies for June 2025, which indicate the broad scale of limited dispersion regionally due to weaker-than-normal winds. These light winds, combined with the high frequency of smoke noted in the previous section, yielded 12 June days with Moderate-or-higher ozone AQI levels and 16 June days with Moderate-or-higher $PM_{2.5}$ AQI levels.

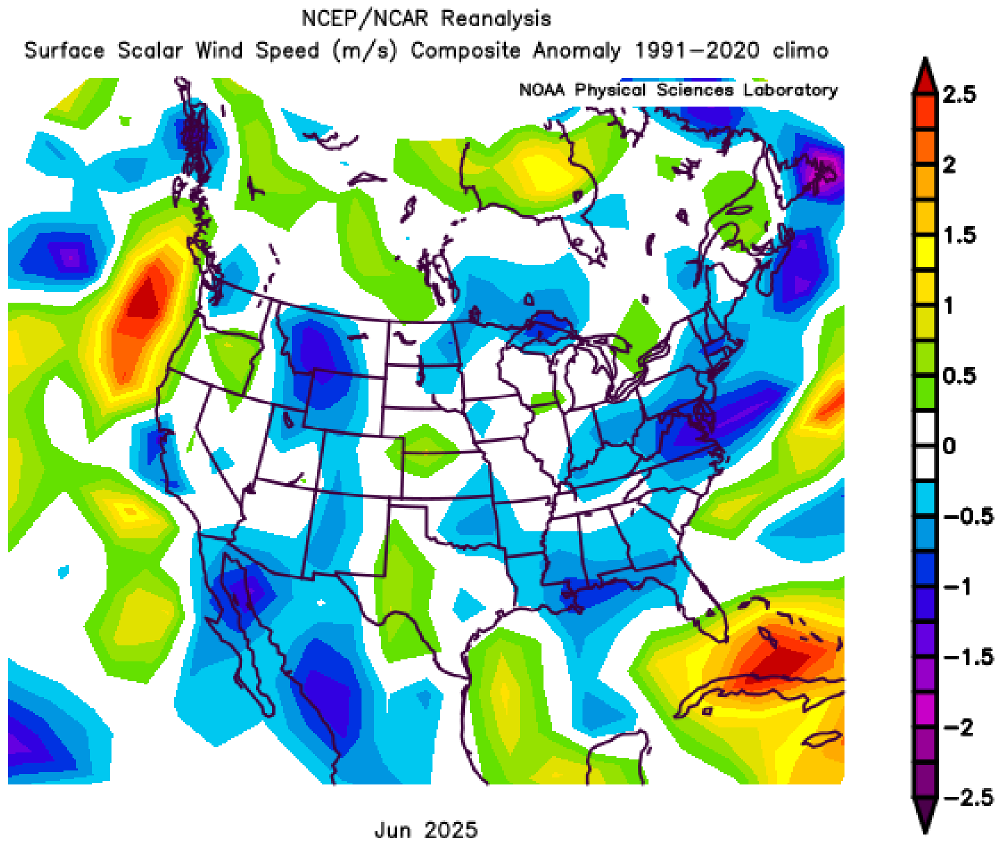

Figure 23. June 2025 surface wind speed anomalies. Blue and purple shading indicate lower-than-normal wind speeds. Source: NOAA.

3. Meteorological Analysis of Days with High AQI Levels in Summer 2025

3.1 Introduction

Based on the daily maximum AQI levels across all Delaware air quality monitoring sites, seven days with USG AQI levels were recorded during summer 2025. Ozone was the primary pollutant on five days, with two $PM_{2.5}$ exceedances occurring in mid-June. Table 7 lists days from May through September 2025 with observed AQI levels above 100. The following section provides a detailed review of the meteorological and air quality conditions for each day with USG AQI levels.

Table 7. Days with observed AQI levels over 100 for the May through September 2025 period. Bold values indicate observed AQI levels exceeding the NAAQS (100 AQI).

Date	Max Observed $PM_{2.5}$ AQI	Max Observed Ozone AQI	Max Pollutant	Max AQI Location	Next-Day $PM_{2.5}$ Forecast	Next-Day Ozone Forecast	Number of Sites > 100 AQI
6/11	62	**108**	O_3	Killens	71	77	1
6/12	74	**133**	O_3	Lums	69	100	5
6/13	**120**	61	$PM_{2.5}$	River Rd Park	60	74	2
6/14	**161**	39	$PM_{2.5}$	River Rd Park	68	50	6
6/24	63	**105**	O_3	Lewes	60	90	1
6/26	57	**108**	O_3	BCSP	58	87	3
8/15	53	**101**	O_3	Killens	53	71	1

3.2 Analysis of Days with High Observed AQI Levels

3.2.1 June 11-12, 2025

During this two-day period, as a surface low pressure system departed Delaware, mostly sunny skies and temperatures warming into the mid- to upper-80s°F supported ozone formation. With the departing low-pressure system positioned to the east and surface high pressure to the west of

Delaware, light northwesterly winds developed on the morning of June 11, followed by light-to-moderate westerly to southwesterly winds through the afternoon of June 11 and much of the day on June 12. These winds transported a broad plume of wildfire smoke into Delaware from fires in western and central Canada.

At the 500-mb level, west-northwesterly winds (**Figure 24**) behind a departing trough of low pressure transported additional aloft smoke over the state of Delaware. As surface temperatures warmed each day, vertical mixing increased, allowing aloft smoke to mix down to the lower levels of the atmosphere. This aloft smoke further increased particle concentrations and enhanced ozone formation.

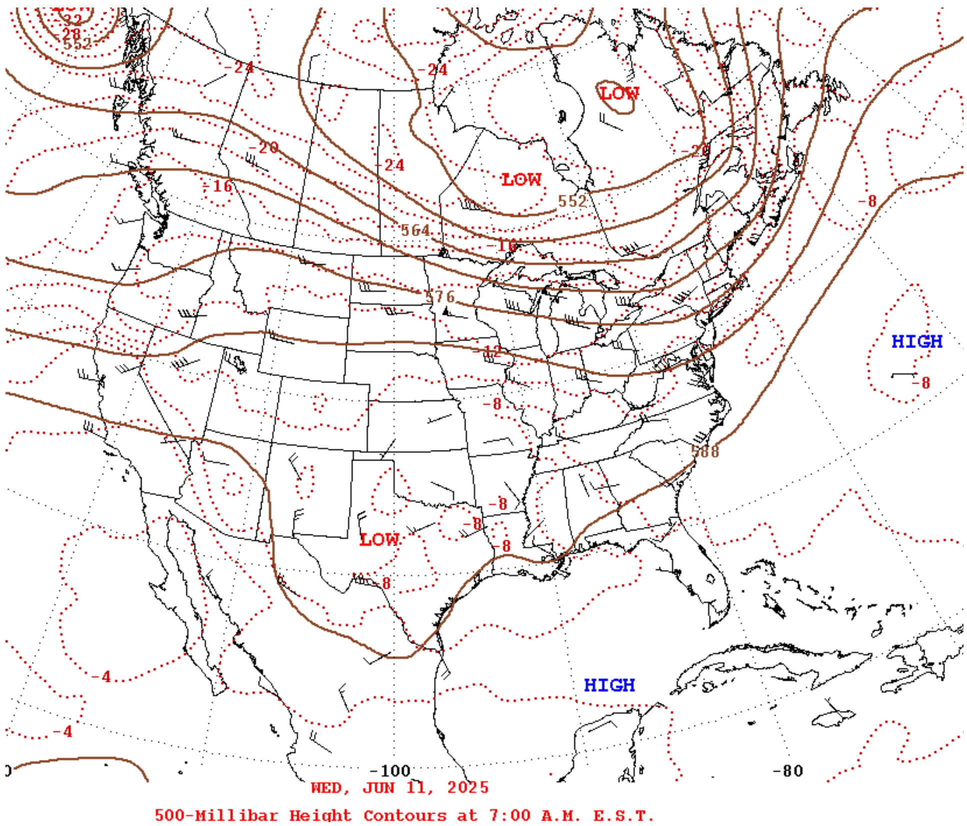

Figure 24. 500-mb heights and winds valid for 8:00 a.m. EDT on June 11, 2025. A trough of low pressure departing the East Coast generated northwesterly winds across the Midwest into Delaware. Image courtesy: NOAA

At the surface, mostly sunny skies and warm temperatures, in combination with significant smoke transport, enhanced ground-level ozone formation, pushing AQI levels into the USG category (Code Orange) for ozone at one site (Killens) on June 11 and at five sites on June 12. The ozone NAAQS exceedances observed in Delaware on June 12 represented just a portion of a broad swath of exceedances at sites stretching from Indiana through Ohio, Pennsylvania, Maryland, Delaware, New Jersey, and New York (**Figure 25**).

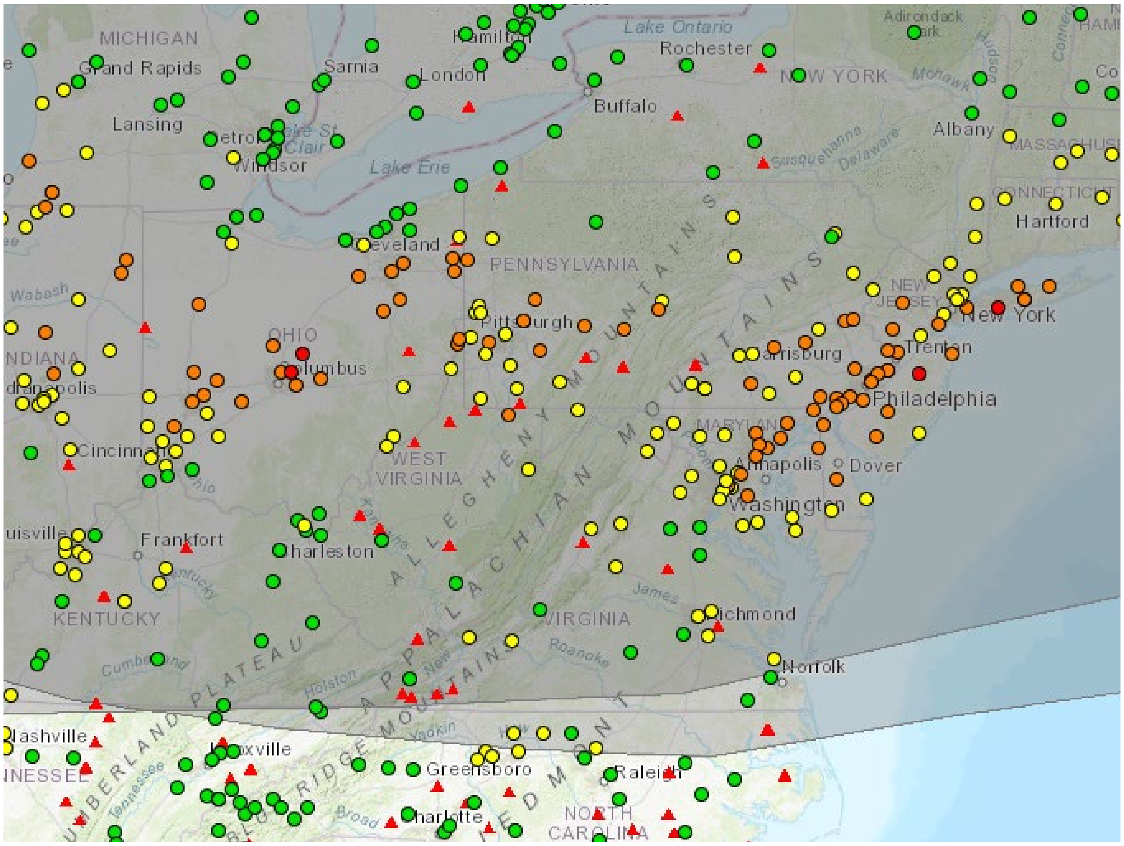

Figure 25. Daily maximum observed ozone AQI levels (colored dots) on June 12, 2025; green dots correspond to Good AQI Levels, yellow dots correspond to Moderate AQI levels, orange dots correspond to Unhealthy for Sensitive Groups AQI levels, and red dots correspond to Unhealthy AQI levels. Gray shading depicts a moderate-density smoke plume over the region, analyzed by the HMS. Image courtesy: AirNow-Tech

3.2.2 June 13-14, 2025

Following the two-day period of smoke transport on June 11–12, which contributed to ozone exceedances on those days, a weak 500-mb ridge of high pressure built over the southeastern United States, extending into the Mid-Atlantic region (**Figure 26**). This weak upper-level ridge reduced atmospheric mixing slightly.

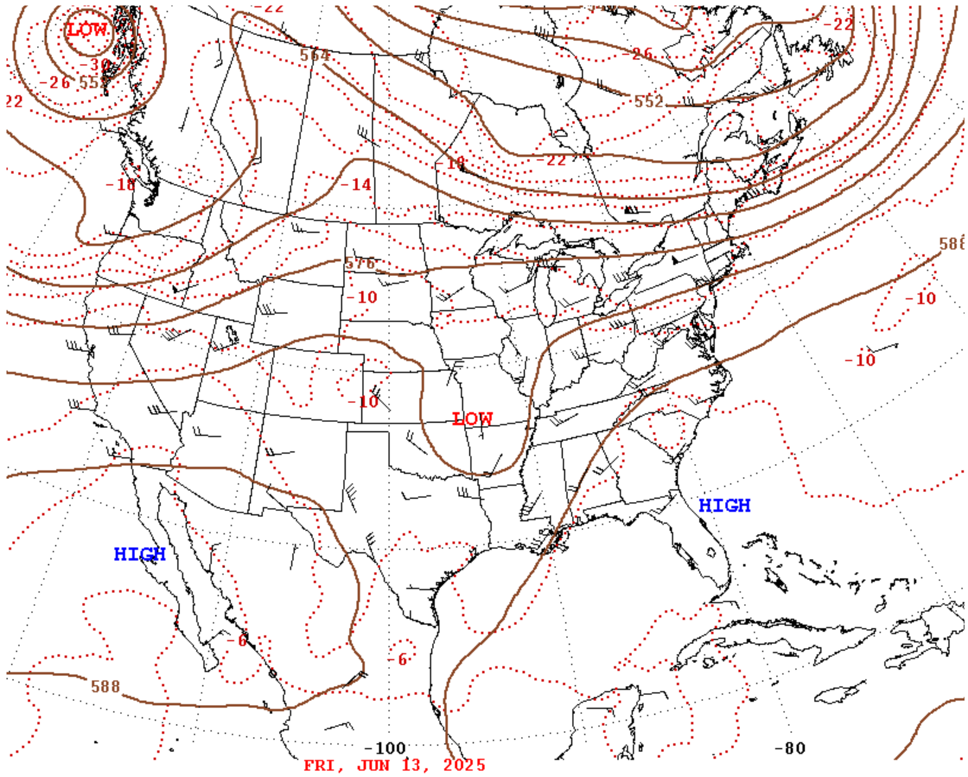

Figure 26. 500-mb heights and winds valid for 8:00 a.m. EDT on June 13, 2025. A weak ridge of high pressure extended from the southeastern United States into the Mid-Atlantic region. Image courtesy: NOAA

At the surface, as a low-pressure system gradually approached from the west, a stationary front developed across Delaware, producing cloud cover that reduced ozone production significantly. Light-to-moderate, easterly-to-northeasterly winds associated with that stationary front aided dispersion. However, these winds also recirculated offshore smoke—originating from fires in Canada—back into Delaware. Additionally, a 6,000-acre wildfire in Wharton State Forest in southern New Jersey (i.e., the Mines Spung Fire) produced dense smoke that was transported directly into northern Delaware by easterly winds late on the evening of June 13 through the morning of June 14. Furthermore, as temperatures cooled on the evening of June 13, a temperature inversion developed, trapping the transported smoke in the lower levels of the atmosphere.

As a result, hourly $PM_{2.5}$ concentrations in excess of 200 $\mu g/m^3$ were observed at multiple sites in western New Jersey, northern Delaware, and southeastern Pennsylvania late on June 13 and in the early hours of June 14. The peak hourly concentration in Delaware during this episode (336.5 $\mu g/m^3$) was observed at the River Road Park, Bellefonte monitor at 4:00 a.m. EDT on June 14 (**Figure 27).**

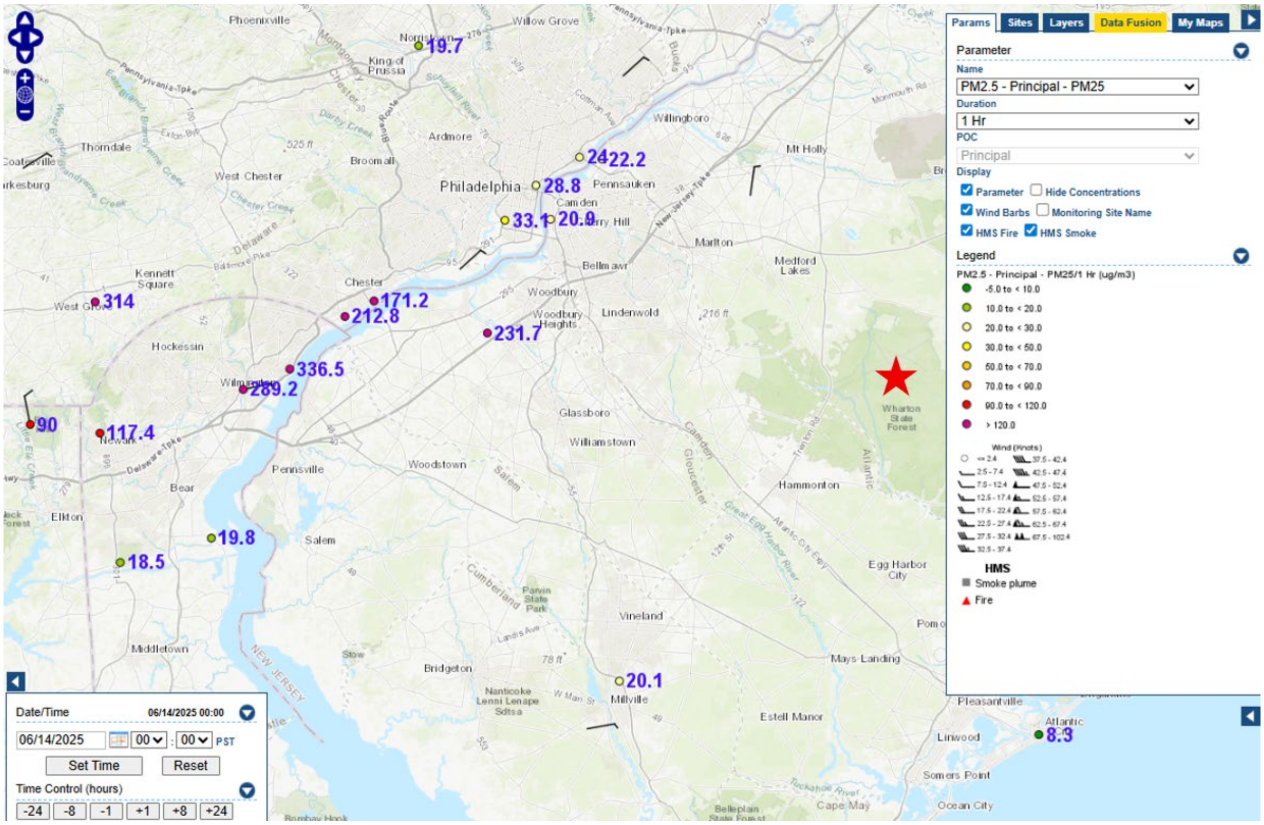

Figure 27. Hourly $PM_{2.5}$ concentrations at 4:00 a.m. EDT on June 14, 2025. Light northeasterly winds carried smoke from a wildfire in the Wharton State Forest in New Jersey directly into northern Delaware on the evening of June 13 and the early morning hours of June 14. Fire location denoted with red star. Image courtesy: AirNow-Tech

Consistent with the increasing cloud cover, ozone AQI levels dropped into the Moderate range on June 13 and into the Good range on June 14. However, the recirculation of regional smoke, combined with smoke from the New Jersey wildfire, yielded $PM_{2.5}$ AQI levels that were in the USG (Code Orange) category on June 13 and the Unhealthy (Code Red) range on June 14. Several sites across southeastern Pennsylvania and northern Delaware recorded daily AQI levels in the Unhealthy category on June 14. The maximum AQI of 161 in northern Delaware on June 14 represented the highest observed AQI level in Delaware for the entire summer for either ozone or $PM_{2.5}$.

By evening of June 14, moderate east-northeasterly winds dispersed the localized smoke and carried a cleaner air mass into northern Delaware, dropping hourly $PM_{2.5}$ concentrations into the single digits in the afternoon. However, the significant spike in hourly concentrations early in the day was sufficient to push the 24-hour average $PM_{2.5}$ concentration into the Unhealthy AQI category.

On both June 13 and June 14, Spheros meteorologists issued Moderate $PM_{2.5}$ forecasts. Significant smoke impacts from the New Jersey fire posed a challenge to both air quality prediction models and forecasters from neighboring agencies. One major contributing factor was cloud cover on the afternoon of June 13 and throughout the day on June 14 (**Figure 28**), which (1) prevented air quality models from detecting and incorporating the New Jersey fire, reducing their ability to accurately predict fire and smoke impacts on regional $PM_{2.5}$ concentrations; and (2) prevented meteorologists from observing the smoke plume using satellite imagery late on June 13 and throughout June 14 in order to accurately assess smoke production and transport.

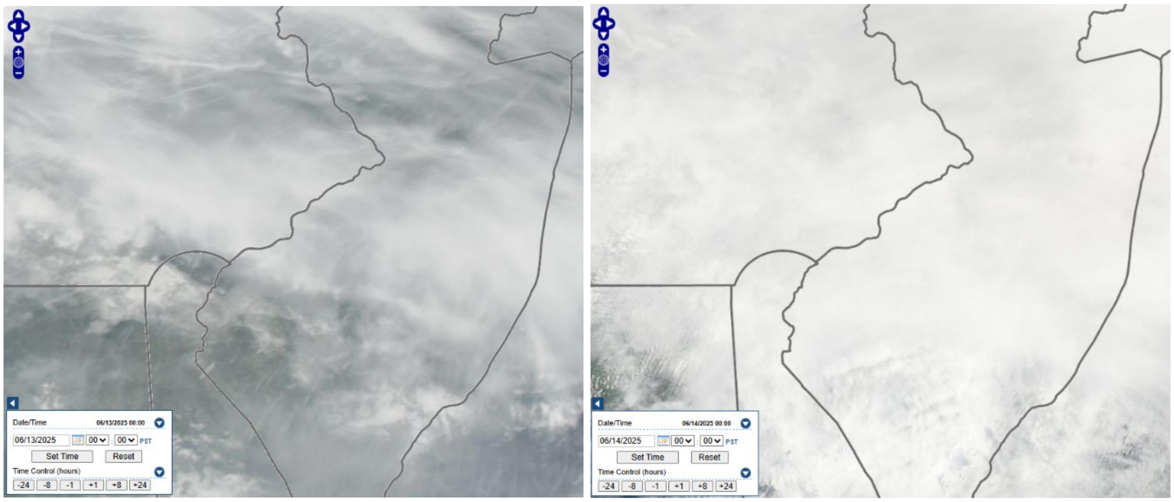

Figure 28. MODIS Aqua visible satellite imagery on the afternoon of June 13 (left) and June 14 (right). Both images depict widespread cloud coverage, which inhibited detections of fire locations and smoke plumes over New Jersey and Delaware during the Mines Spung Fire. Image courtesy: AirNow-Tech

Finally, in addition to local smoke production, the transport of offshore smoke into Delaware presented a particular challenge due to the lack of upwind $PM_{2.5}$ monitors offshore. As a result of these conditions, observed $PM_{2.5}$ concentrations were underpredicted for Delaware and neighboring states.

In response to this fire and the high AQI levels observed on June 13 and 14, Spheros meteorologists issued a Code Orange Air Quality Alert on June 15. More information on this forecast can be found in Section 3.3.1.

3.2.3 June 24, 2025

An isolated ozone NAAQS exceedance occurred at the Lewes monitoring site on June 24. Spheros meteorologists issued a next-day ozone AQI forecast of 90, as a strong area of high pressure aloft over the eastern United States inhibited atmospheric mixing and yielded ample sunshine and surface temperatures over 100°F. In addition, ozone formation was anticipated to be aided by smoke over the Mid-Atlantic region due to wildfires across Alaska, Canada, northwestern Mexico, and southwestern Utah. These conditions were favorable for ground-level ozone production, which developed as expected during the day.

One deviation from the forecast related to the winds. Surface high pressure west of Delaware generated calm-to-light, northerly-to-northwesterly winds in the Lewes area. These winds were weaker than winds over the rest of the state, which allowed pollutants to accumulate. Furthermore, these winds allowed ozone precursors from southern New Jersey and the Philadelphia area to reach southeastern Delaware. **Figure 29** shows the 12-hour back-trajectory analysis ending at 2:00 p.m. (EDT) June 24, which illustrates the pollutant transport path into Lewes.

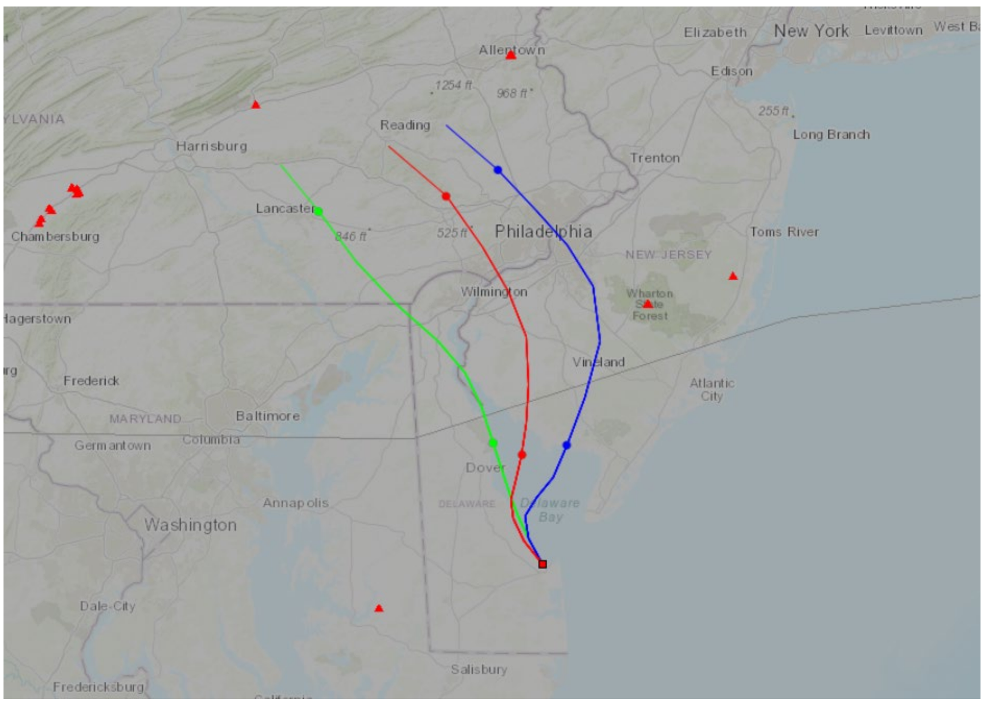

Figure 29. 12-hr back trajectory analysis (green: 50 m above ground level, blue: 500 m, red: 1,000 m) ending at 2:00 p.m. EDT on June 24, 2025. Northerly-to-northwesterly winds gradually transported ozone precursors and wildfire smoke (grey shading) into Lewes, which enhanced ozone production. Image courtesy: AirNow-Tech

These conditions, combined with pollutant carryover from the prior days, led to a daily AQI of 105 at Lewes, with a maximum hourly ozone concentration of 88 ppb during the 2:00–3:00 p.m. reporting period. For the remainder of the state, daily observed ozone levels ranged in AQI from 61–84.

3.2.4 June 26, 2025

Ozone AQI exceeded the NAAQS at three air quality monitors in New Castle Country (BCSP, LUM, and MLK) on June 26. Spheros meteorologists issued a next-day AQI forecast of 87 for this day, as mostly sunny skies and warm temperatures were anticipated to promote ozone development, and light winds were expected to limit dispersion. Additionally, lingering smoke was expected to enhance ozone formation. However, scattered thunderstorms were forecast to arrive during the late afternoon and evening, dispersing pollutants and decreasing ozone production.

Observed weather conditions on June 26 deviated from the initial forecast. While warm temperatures in the mid-90s°F developed as expected, scattered storm development did not arrive in northern Delaware until 7:00 to 8:00 p.m. **Figure 30** shows radar imagery from the evening of June 26 as severe thunderstorms entered New Castle County. Due to the delayed onset of storms, more sunshine led to an increase in ozone production throughout the day.

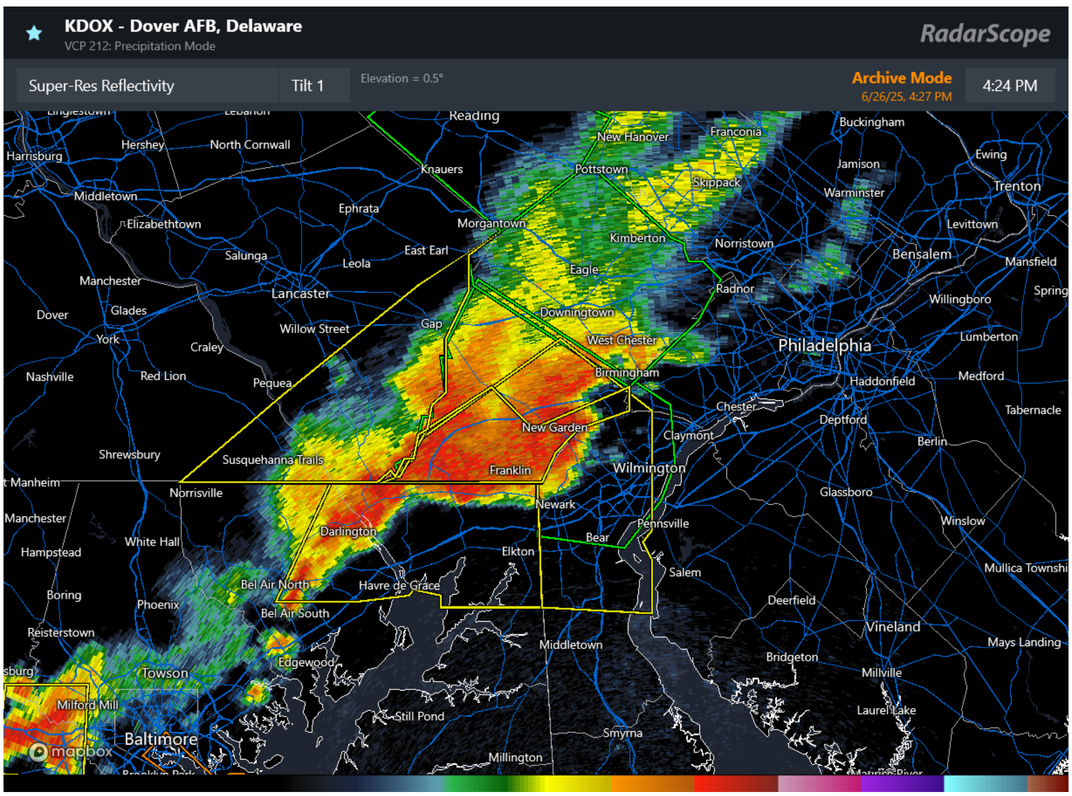

Figure 30. Radar imagery valid 7:24 p.m. (EDT) on June 26. New Castle County was under a Severe Thunderstorm Warning (yellow polygon) and Flash Flood Warning (green polygon) as thunderstorms approached northern Delaware. The delayed onset of thunderstorms led to higher-than-expected ozone AQI levels. Image courtesy: Radarscope

Furthermore, from the morning to late afternoon hours, calm-to-light, northerly-to-northeasterly winds prevailed across New Castle County. These winds limited dispersion and gradually carried ozone precursors and other pollutants from Philadelphia and the New York City area into northern Delaware, further increasing ozone formation. The combination of more sunshine, pollutant transport into New Castle County, warm temperatures, and smoke resulted in a daily max AQI of 108 at BCSP; the LUM and MLK sites each recorded a daily max AQI of 105.

3.2.5 August 15, 2025

The last day of high AQI levels in Delaware during the summer of 2025 occurred in the middle of August, as a large plume of thin smoke arrived over the Mid-Atlantic. The plume of smoke was produced by wildfires in Canada and the western United States and was transported into the region by a weak cold front that arrived late on August 14 (**Figure 31**).

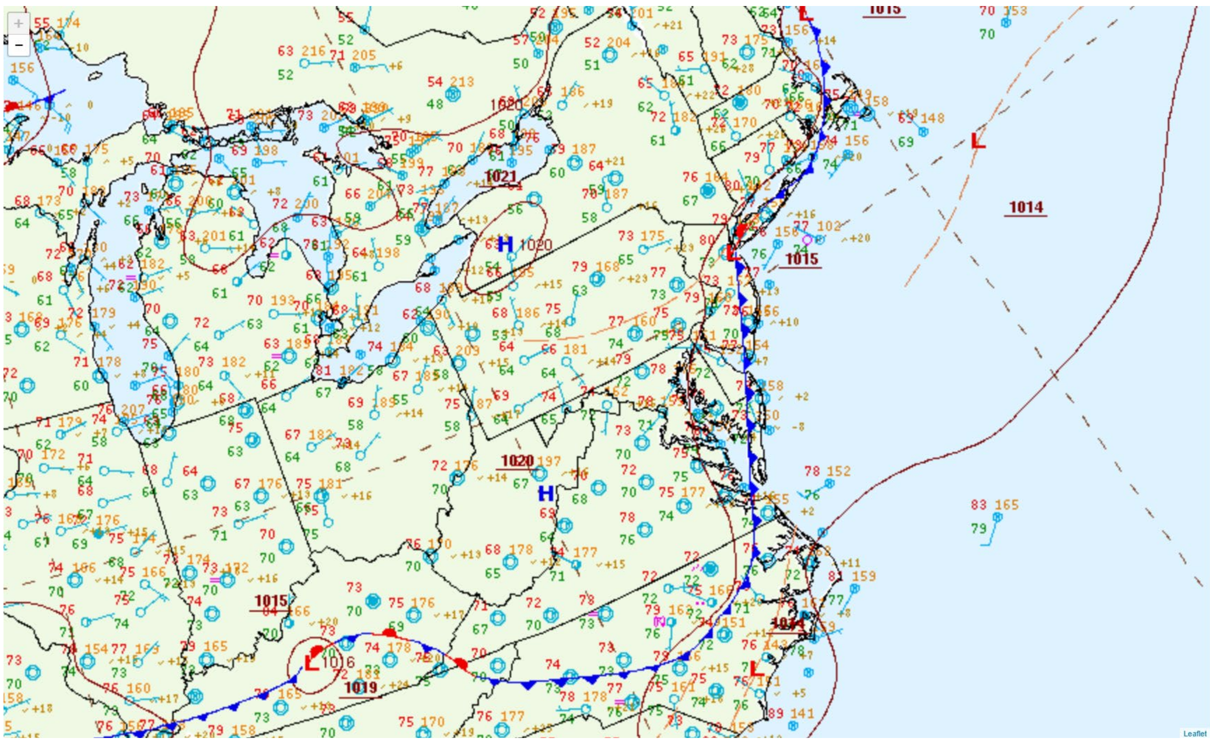

Figure 31. Surface analysis from 3:00 UTC (11:00 p.m. EDT, August 14, 2025) shows a weak cold front had crossed much of the state. Image courtesy: NOAA's Weather Prediction Center

As the front moved across the state between 8:00 and 11:00 p.m. EDT, ozone concentrations at the Killens ozone monitor dropped from 28 to 4 ppb. This sudden drop likely indicated the presence of NO_x in the smoke plume, which titrated ozone concentrations at the rural monitoring site and primed the boundary layer for ozone production the following day. Ozone concentrations reached a minimum of 1 ppb early on August 15. In addition to the titration, satellite imagery provides further evidence of smoke over the region on August 15 (**Figure 32**).

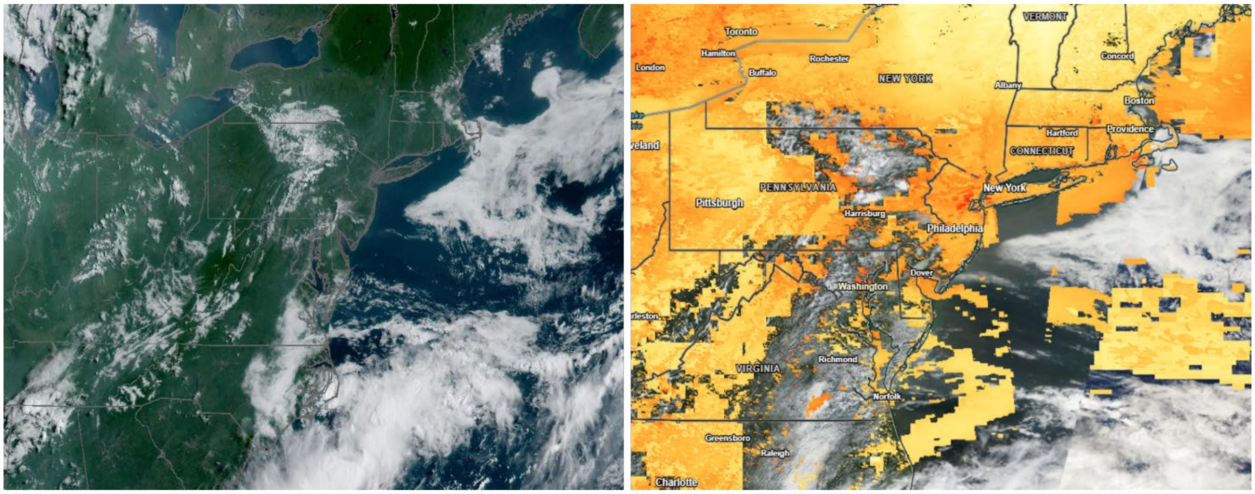

Figure 32. Visible haze (left) at 13:01 UTC (9:01 a.m. EDT, August 15, 2025) and a regionally elevated aerosol optical depth (AOD) composite (right) provide satellite-based evidence of smoke over the Mid-Atlantic. Visible satellite courtesy of NOAA's AersolWatch. AOD composite courtesy of NASA's Worldview. AOD satellite composites include information from MODIS/Terra and MODIS/Aqua.

Once the smoke and elevated ozone precursors arrived in Delaware, additional meteorological conditions were conducive to ozone development on this day. Figure 33 shows an upper-level ridge of high pressure along the East Coast on the morning of August 15.

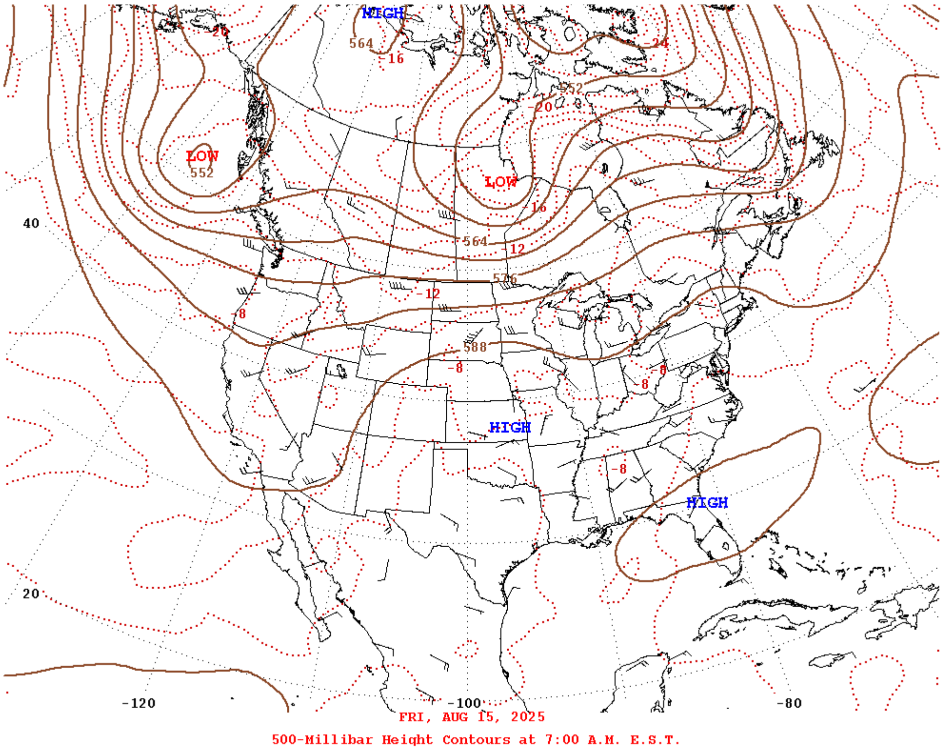

Figure 33. 500 mb heights (solid lines: decameters) and temperatures (dashed lines: °C) at 12:00 UTC on August 15, 2025. Image courtesy: NOAA's Weather Prediction Center

Vertical mixing was reduced as the ridge aloft traversed the region. Easterly winds blowing across the cool waters in the Delaware Bay also reduced mixing heights during the late afternoon and evening, confining pollutants near the surface. In addition, as the ridge moved over the region, partly to mostly sunny skies and highs near 90°F aided ozone formation. These conditions resulted in low- to mid-Moderate AQI levels at most ozone monitors across Delaware, similar to the next-day ozone forecast of 71 AQI. However, an additional factor enhanced ozone formation over south-central Delaware: the cold front that had helped transport smoke into the region the previous evening moved back to the north and stalled near the Killens ozone monitor on the afternoon of August 15 (**Figure 34**).

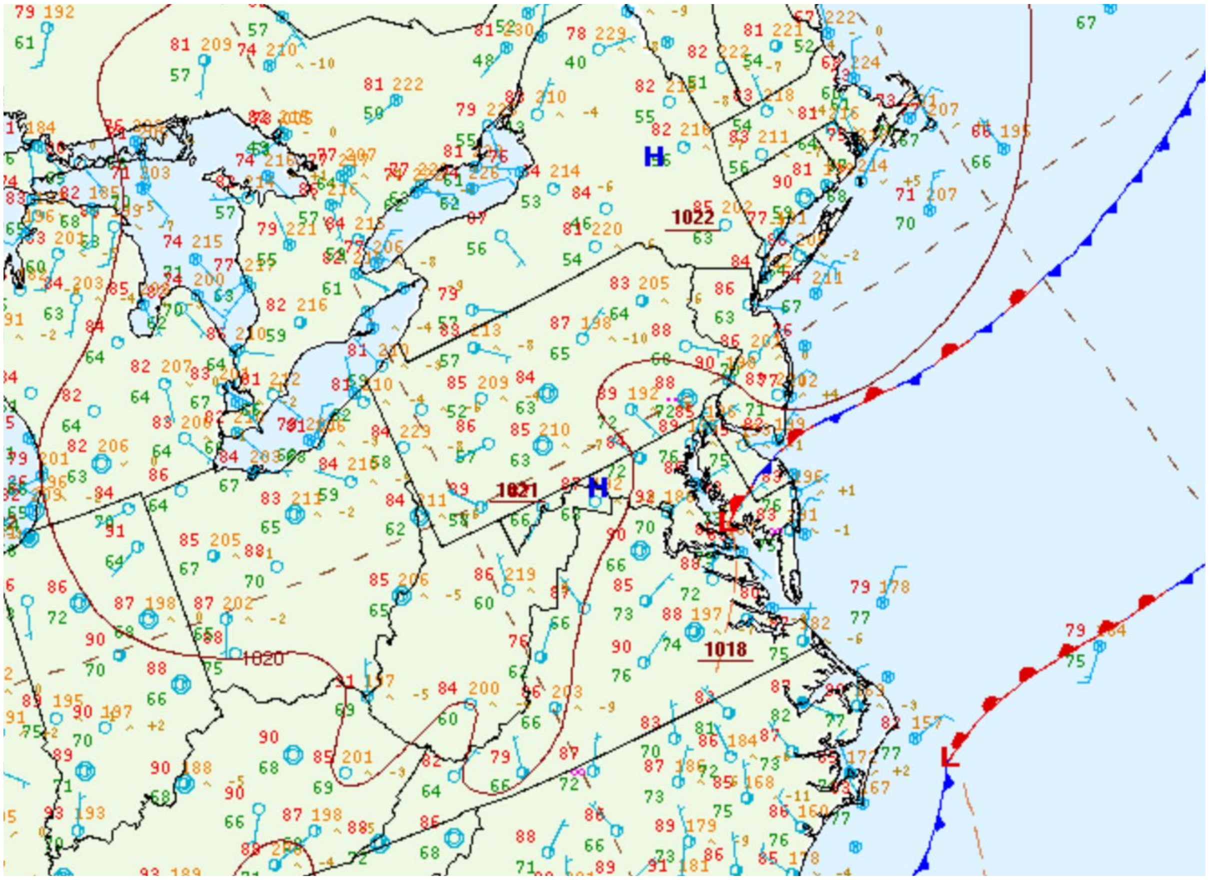

Figure 34. Surface analysis at 18 UTC, August 15, 2025 (2:00 p.m. EDT), shows a stationary front over south-central Delaware. Image courtesy: NOAA's Weather Prediction Center

Converging winds along the front allowed pollutants to accumulate over south-central parts of the state, leading to maximum hourly ozone values of 79 ppb, and a daily maximum 8-hour average of 71 ppb (101 AQI) at Killens.

3.3 Air Quality Action Day Forecasts for Summer 2025

When the next day's AQI levels are anticipated to exceed 100, Spheros meteorologists will issue an Air Quality Action Day for the state of Delaware. The issuance of an Action Day forecast aims to (1) minimize health impacts for the general public; and (2) alert industry and residents to curb emission-related activities that contribute to poor air quality. For next-day forecasts between 101 and 150 AQI, a Code Orange Air Quality Action Day is issued. In rare instances that AQI values are anticipated to exceed 150, a Code Red Air Quality Action Day will be issued. During the summer 2025 forecasting season, Spheros meteorologists issued six Code Orange Air Quality Action Day forecasts; no Code Red Air Quality Action Day forecasts were issued. Of the six Code Orange Air Quality Action Days issued, four were issued due to expected high ozone levels, with two forecasts for expected $PM_{2.5}$ AQI levels exceeding 100 AQI.

Table 8 lists all Code Orange Air Quality Action Day forecasts issued for the state of Delaware in summer 2025, along with the observed AQI values for ozone and $PM_{2.5}$. The following section provides a detailed review of each Code Orange Air Quality Action Day forecast and the resulting observed AQI levels.

Table 8. Code Orange Air Quality Action Day forecasts during the May through September 2025 period. Bold values indicate forecast AQI levels above the NAAQS.

Date	Max Observed $PM_{2.5}$	Max Observed Ozone	Max Pollutant	Next-Day $PM_{2.5}$ Forecast	Next-Day Ozone Forecast
6/15	50	32	$PM_{2.5}$	**102**	46
6/22	56	47	$PM_{2.5}$	55	**101**
7/5	66	64	$PM_{2.5}$	71	**101**
7/29	58	74	O_3	64	**101**
8/4	68	58	$PM_{2.5}$	56	**101**
8/6	80	37	$PM_{2.5}$	**102**	42

3.3.1 June 15, 2025

The season's first Code Orange Action Day for Delaware was issued on June 15 for $PM_{2.5}$. Prior to this day, the Mines Spung Fire ignited on June 13 in the Wharton State Forest in New Jersey, with smoke from this fire reaching northern Delaware the evening of June 13 and lingering across portions of the state through the evening of June 14 (**Figure 35**). With surface high pressure expected to remain north of Delaware on June 15, east-northeasterly winds were anticipated to carry additional smoke into the state. Furthermore, because observed AQI levels in Delaware exceeded 100 AQI the previous four days, pollutant carryover was expected to be high. These conditions led to a next-day $PM_{2.5}$ AQI forecast of 102 for June 15.

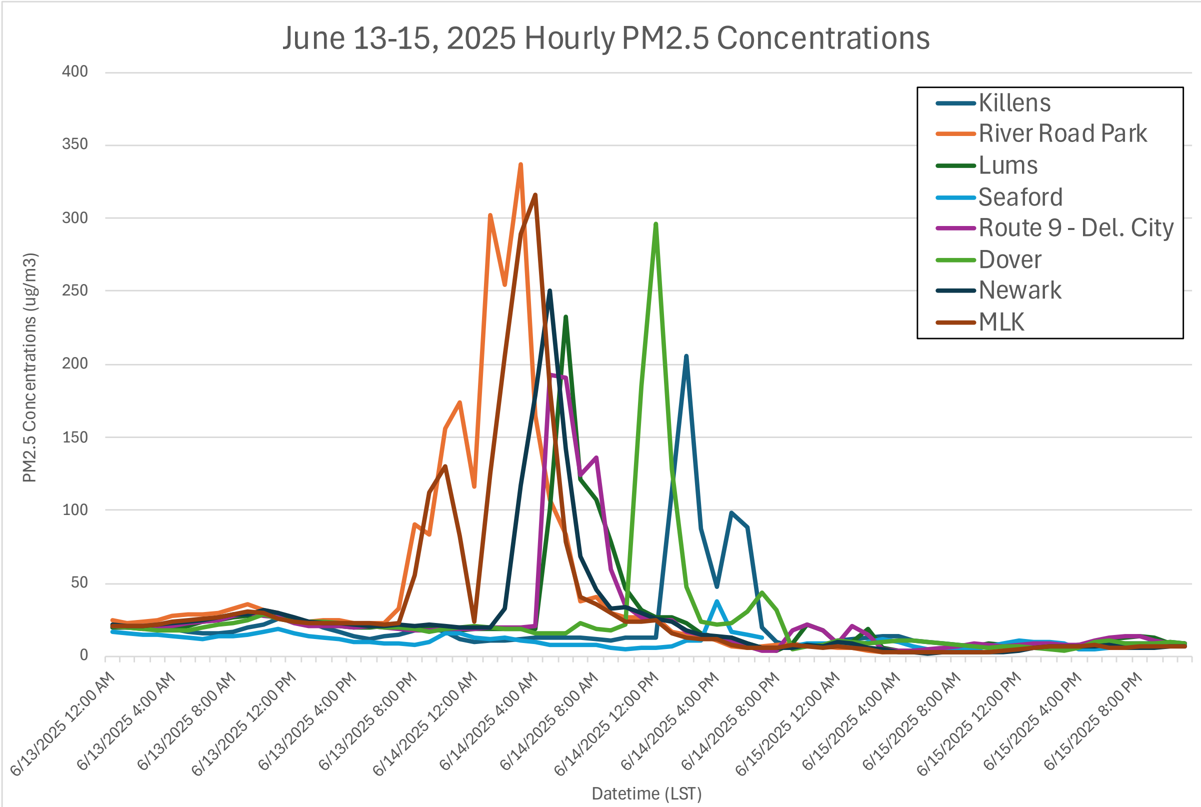

Figure 35. Time series of hourly $PM_{2.5}$ AQI concentrations on June 13–15, 2025, for all Delaware $PM_{2.5}$ monitoring sites. Dense smoke from the Mines Spung Fire in New Jersey resulted in a sharp increase in $PM_{2.5}$ concentrations in Delaware on June 13–14. Timestamps listed are in begin-hour (i.e., 12:00 p.m. is equivalent to the data reading during the 12:00-1:00 p.m. hour). Source: AirNow-Tech.

On June 15, east-northeasterly winds developed across Delaware and southern New Jersey. However, smoke production from the Mines Spung Fire greatly diminished throughout the day on June 14. This decrease in smoke production allowed east-northeasterly winds to carry clean air into the First State, which resulted in lower-than-expected $PM_{2.5}$ AQI levels. As a result, the daily maximum 24-hour $PM_{2.5}$ AQI observation in Delaware for June 15 was 50 at the Route 9 – Delaware City monitoring site.

3.3.2 June 22, 2025

Spheros meteorologists issued the season’s second Code Orange Air Quality Action Day for Delaware on June 22. Forecast conditions expected on this day included (1) upper-level high pressure west of the state reducing vertical mixing; and (2) sunny skies and high temperatures in the mid-90s°F promoting ground-level ozone development. Additionally, periods of light southwesterly winds were expected to reduce dispersion and gradually carry regional pollutants into Delaware.

These conditions resulted in numerous air quality agencies across the Mid-Atlantic region, along with Delaware DNR, issuing next-day ozone AQI forecasts in the USG category.

Observed weather conditions on June 22 greatly varied from the initial forecast. A decaying complex of thunderstorms moved into Delaware from the north during the late morning and early afternoon hours, which aided vertical mixing and reduced regional pollutants and ozone precursors. Clouds associated with this complex (**Figure 36**) also limited the sunlight necessary to support ozone formation, and afternoon high temperatures peaked in the upper-80s to low-90s°F across the First State, which was roughly 5°F cooler than expected. As a result, all Delaware ozone monitoring sites recorded a daily maximum 8-hour average ozone AQI in the Good category, with the highest level being 47 AQI at Lums.

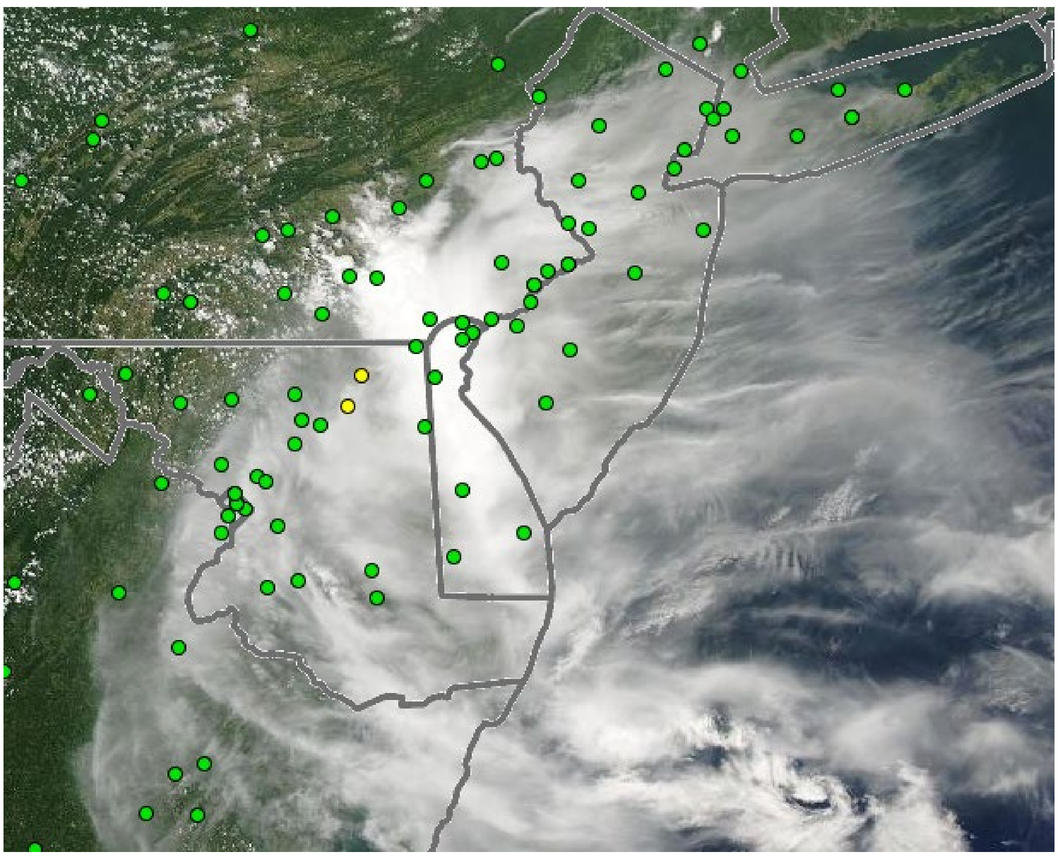

Figure 36. MODIS Aqua satellite imagery on June 22, 2025, and daily maximum 8-hour average ozone AQI levels (dots). Cloud cover and the associated cooler temperatures from a decaying thunderstorm complex inhibited ozone production, yielding Good ozone AQI levels (green dots) across much of the Mid-Atlantic region. Source: AirNow-Tech.

3.3.3 July 5, 2025

The season's third Code Orange Air Quality Action Day for Delaware was issued for July 5. Spheros meteorologists indicated the potential for carryover of ozone precursors from wildfire smoke, along with lingering emissions from holiday fireworks. In addition, forecast models suggested the potential for additional pollutants and ozone precursors to be carried into northern Delaware from the Philadelphia metropolitan area during the early morning hours, followed by light afternoon winds inhibiting dispersion. Furthermore, upper-level high pressure west of the state was anticipated to reduce mixing and yield sunny skies with afternoon high temperatures in the upper-80s°F, promoting ozone formation. As a result, a USG next-day ozone AQI forecast was issued for the First State.

Observed weather conditions generally followed the anticipated forecast. Abundant sunshine was prevalent throughout much of the day, and recorded high temperatures across the state were around 85–90°F. NOAA HMS analyzed smoke across the Mid-Atlantic region, originating from fires in Alaska and western Canada. This smoke, combined with holiday firework emissions, resulted in Delaware $PM_{2.5}$ monitoring sites recording Moderate AQI levels. However, the expected wind pattern did not materialize. During the overnight and early morning hours, winds across New Castle County were light but generally westerly to west-northwesterly; they failed to produce transport from the Philadelphia area. By the afternoon, southerly to southeasterly winds were slightly stronger than forecast, which aided dispersion and inhibited ozone development (**Figure 37**). Reduced emissions from factories and vehicles due to the weekend also contributed to limited ozone formation. Due to these conditions, daily maximum ozone AQI levels were in the high-Good to low-Moderate AQI category across the state, with the Killens monitoring site recording the highest ozone AQI value for the day (64 AQI).

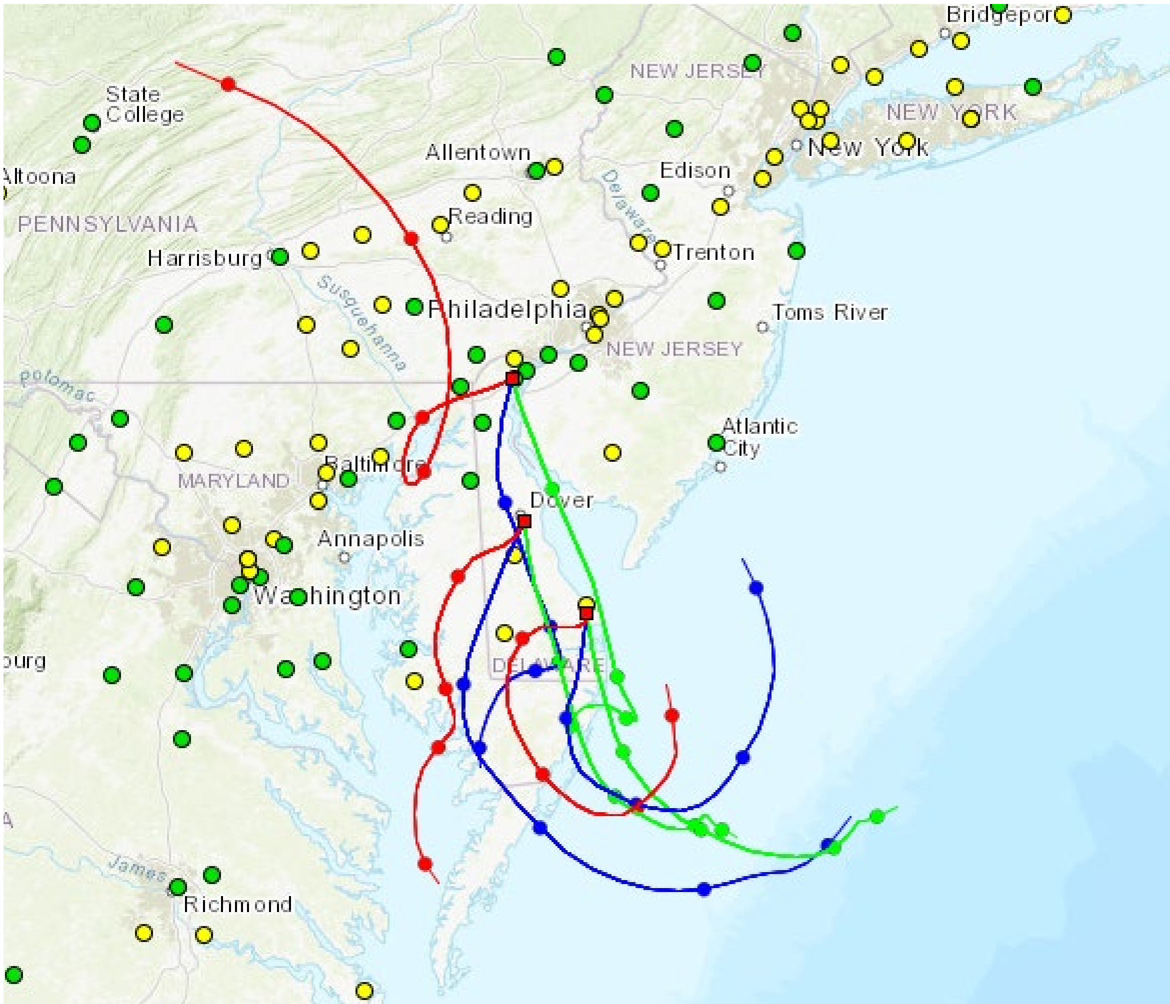

Figure 37. 24-hour back trajectories ending at 11:00 pm EDT on July 5, 2025 (green – 10 m AGL, blue – 500 m AGL, red – 1,000 m AGL) and daily maximum 8-hour average ozone AQI values (dots) for July 5, 2025. Southerly to south-southeasterly winds into Delaware aided dispersion, resulting in Good (green dots) to Moderate (yellow dots) ozone AQI values regionally. Source: AirNow-Tech.

3.3.4 July 29, 2025

Spheros meteorologists issued the season's fourth Code Orange Air Quality Action Day for July 29. Forecast weather conditions on this day included mostly sunny skies and afternoon high temperatures reaching the upper-90s°F, promoting ozone development. Additionally, a morning temperature inversion was expected to confine ozone precursors near the ground, while calm-to-light westerly winds were anticipated to limit dispersion during the day. These conditions, in conjunction with ozone carryover from the previous day, led to a next-day ozone AQI forecast in the USG category for Delaware, with forecasters for metropolitan Philadelphia also issuing a USG ozone forecast.

On July 29, mostly sunny skies developed, and a morning inversion, followed by calm-to-light and variable winds, hindered dispersion. These conditions allowed observed $PM_{2.5}$ AQI levels to reach the Moderate category. However, recorded afternoon high temperatures across much of Delaware peaked in the low- to mid-90s°F, which was slightly cooler than expected (**Figure 38**). Of greater impact on ozone development on July 29 was the anticipated carryover of pollutants from the prior day being lower than forecast. The July 28 ozone AQI forecast was 84 AQI (mid-Moderate), but Good to low-Moderate ozone AQI levels were recorded statewide on this day instead. Due to the low carryover and slightly cooler temperatures, the observed daily maximum ozone AQI levels for July 29 ranged from 47 AQI at BCSP to 74 AQI at the Lums and Lewes ozone monitoring sites.

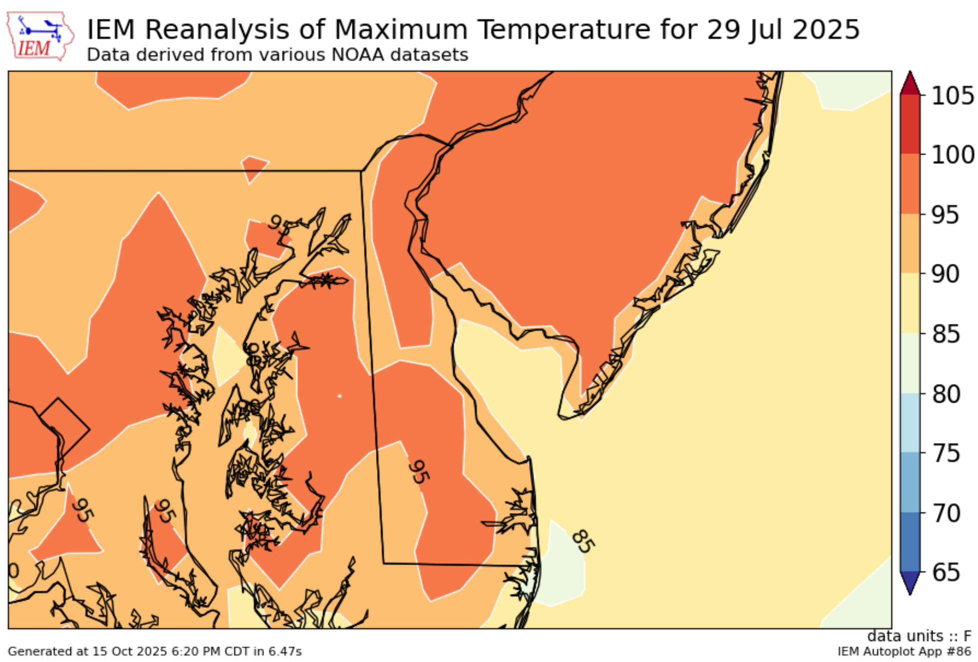

Figure 38. Maximum high temperatures for July 29, 2025. Across Delaware and the Mid-Atlantic region, highs reached the low- to mid-90s°F, while forecast highs for this date in Delaware were expected to reach the upper-90s°F. Source: Iowa State Mesonet.

3.3.5 August 4, 2025

The season's fifth Code Orange Air Quality Action Day was issued for August 4. Spheros meteorologists expected calm-to-light and variable winds to develop along the I-95 corridor, which would reduce dispersion of pollutants and ozone precursors. Furthermore, sunny skies were forecast, which would allow afternoon high temperatures to reach the upper-80s°F, promoting ozone production. Additionally, a broad plume of Canadian smoke was forecast to move over the region, increasing the likelihood of smoke enhancement of ground-level ozone formation. Lastly, the National Air Quality Forecast Capability (NAQFC) air quality model, which had recently been performing well for Delaware, predicted ozone AQI levels in the high-Moderate to low-USG range on

August 4. As a result, the next-day ozone AQI forecast was 101 AQI, which is on the low end of the USG category.

On August 4, calm winds prevailed during the overnight and early morning hours. In addition, a plume of smoke was observed over Delaware, supported by both the HMS smoke analysis and increased $PM_{2.5}$ concentrations. However, from 7:00 to 11:00 a.m. EDT, a period of northerly-to-northwesterly winds developed in New Castle County. While these winds were light, they aided dispersion of pollutants and ozone precursors that developed during the morning rush hour along the I-95 corridor.

Furthermore, a narrow cloud band developed directly over northern Delaware in the mid-afternoon, reducing ozone formation during prime ozone-production hours (**Figure 39**). Therefore, despite high temperatures in the mid- to upper-80s°F in New Castle County, observed daily maximum 8-hour average ozone concentrations were in the low-Moderate AQI range, with a state maximum ozone AQI of 58 at the Seaford monitoring site. Although the nearby Clarksboro site in southwestern New Jersey did record a NAAQS exceedance for ozone (73 ppb) on this day, the northerly winds and cloud cover over northern Delaware were sufficient to keep ozone levels below the NAAQS.

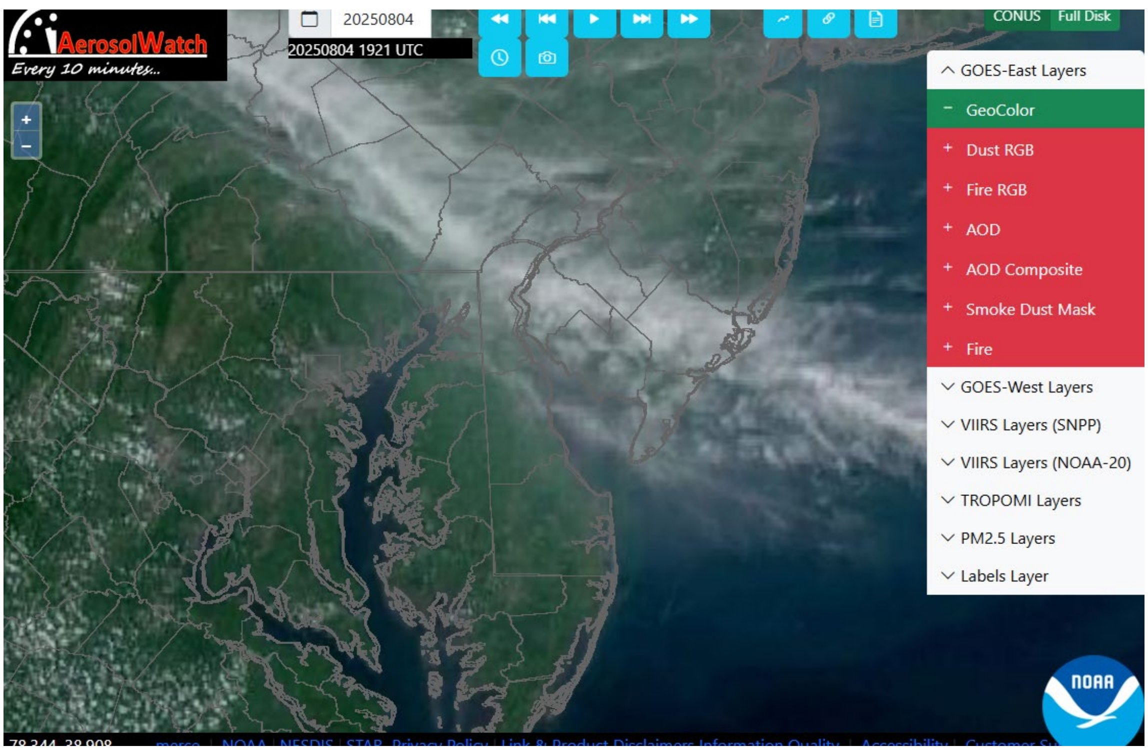

Figure 39. GOES East visible satellite imagery, August 4, 2025, at 19:21 UTC (3:21 p.m. EDT). Cloud cover across northern Delaware reduced ozone formation in the afternoon, yielding lower-than-predicted ozone AQI levels. Source: NOAA AerosolWatch.

3.3.6 August 6, 2025

The final Code Orange Air Quality Action Day for Delaware was issued for August 6. Leading up to this day, Spheros meteorologists were tracking a plume of Canadian wildfire smoke off the Atlantic coast, as shown in **Figure 40**. With winds forecast to be east-northeasterly on August 6, this smoke plume was anticipated to move into the Mid-Atlantic region and increase $PM_{2.5}$ AQI levels. Despite the chance for scattered showers and thunderstorms, Spheros meteorologists were concerned that the bulk of the offshore smoke was near the surface, which would negatively impact public health. This reasoning resulted in a $PM_{2.5}$ AQI forecast in the USG category.

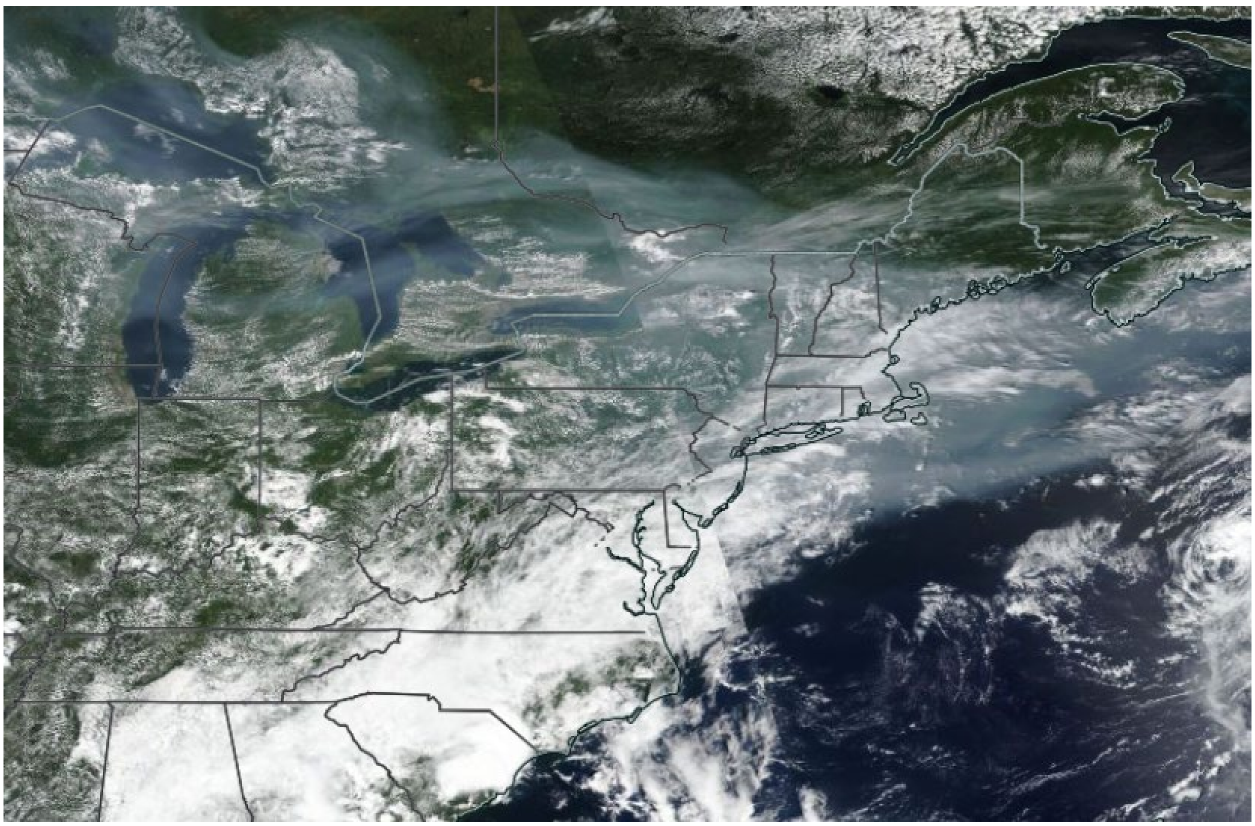

Figure 40. Suomi VIIRS satellite image valid August 5, 2025. Canadian wildfire smoke was detected off the northeastern United States coast, with forecast winds for August 6 expected to draw smoke into Delaware. Source: NASA Worldview.

On August 6, the expected scattered rain showers did not materialize, with only light rainfall recorded at a few weather stations in central and southern Delaware. On the other hand, the expected east-northeasterly winds did verify statewide, which drew the offshore smoke plume into the First State, raising particle concentrations. For numerous hours, $PM_{2.5}$ monitoring sites across the state recorded hourly concentration values over 30 µg/m^3, followed by a drop in concentrations in the late evening. While concentration values were higher than normal at the surface, the mostconcentrated portion of the smoke plume likely stayed above ground level, as cloud cover reduced the daytime heating needed for vertical mixing that would transfer aloft smoke to the surface. These conditions resulted in daily $PM_{2.5}$ AQI levels in the Moderate category for all Delaware $PM_{2.5}$ monitoring sites, with a statewide maximum AQI of 80 recorded at the River Road Park monitor. It should be noted that due to the lack of surface data used to measure air quality, predicting $PM_{2.5}$ concentrations over the Atlantic Ocean is challenging. As a result, Spheros meteorologists err on the side of caution and issue conservative forecasts in these situations to protect the general public from potential health impacts due to dangerous levels of smoke.

4. Accuracy of Air Quality Forecasts in 2025

4.1 Spheros Forecast Performance

During Delaware's summer 2025 forecast season, Spheros meteorologists issued daily ozone and $PM_{2.5}$ forecasts for the next day and following two days from April 30 through September 30. In the following sections, the performance of Spheros' next-day forecasts for ozone and $PM_{2.5}$ are analyzed and compared with previous years' forecast statistics.

4.1.1 2025 Ozone Forecast Statistics

A comparison between Spheros forecasts and observed ozone AQI levels in Delaware for summer 2025 is shown in **Figure 41**. The forecasts generally track the observed AQI levels. Due to the small number of USG ozone forecasts issued, the Good-to-Moderate threshold was used to verify forecast accuracy. Supplementary information on forecasts of high-ozone days can be found in Section 3.2. For summer 2025, Spheros next-day ozone forecasts in Delaware were correct 75% of the time, which is the highest Percent Correct (PC) since the 2022 summer forecast season.

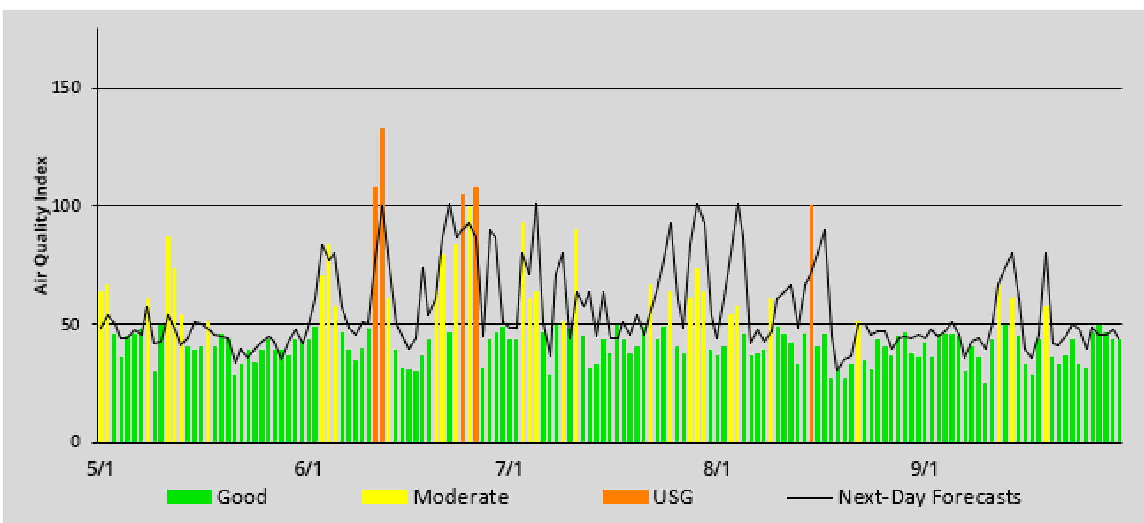

Figure 41. Daily observed 2025 ozone AQI levels (bars) in Delaware versus Spheros next-day AQI forecasts (black line).

Moderate-or-higher ozone AQI levels were observed on 37 out of the 153 forecast days in summer 2025. Spheros meteorologists issued forecasts at the Moderate AQI level on 31 of the 37 days with observed Moderate-or-higher ozone AQI levels, resulting in a Probability of Detection (POD) of 84% for days with Moderate ozone AQI levels. In the previous forecast season, the POD was 89%.

Forecast false alarms occur when the forecast ozone AQI category is higher than the observed ozone AQI category. Of the 64 days during summer 2025 when Moderate-or-higher ozone AQI levels were forecast, there were 33 instances when observed ozone AQI levels were lower than the forecast AQI levels (i.e., in the Good AQI category). As a result, the False Alarm Rate (FAR) for Moderate-or-higher ozone AQI forecasts during summer 2025 was 52%, which similar to the FAR in summer 2024 (51%). Figure 42 shows a comparison of PC, POD, and FAR for Spheros ozone forecasts over the last five years.

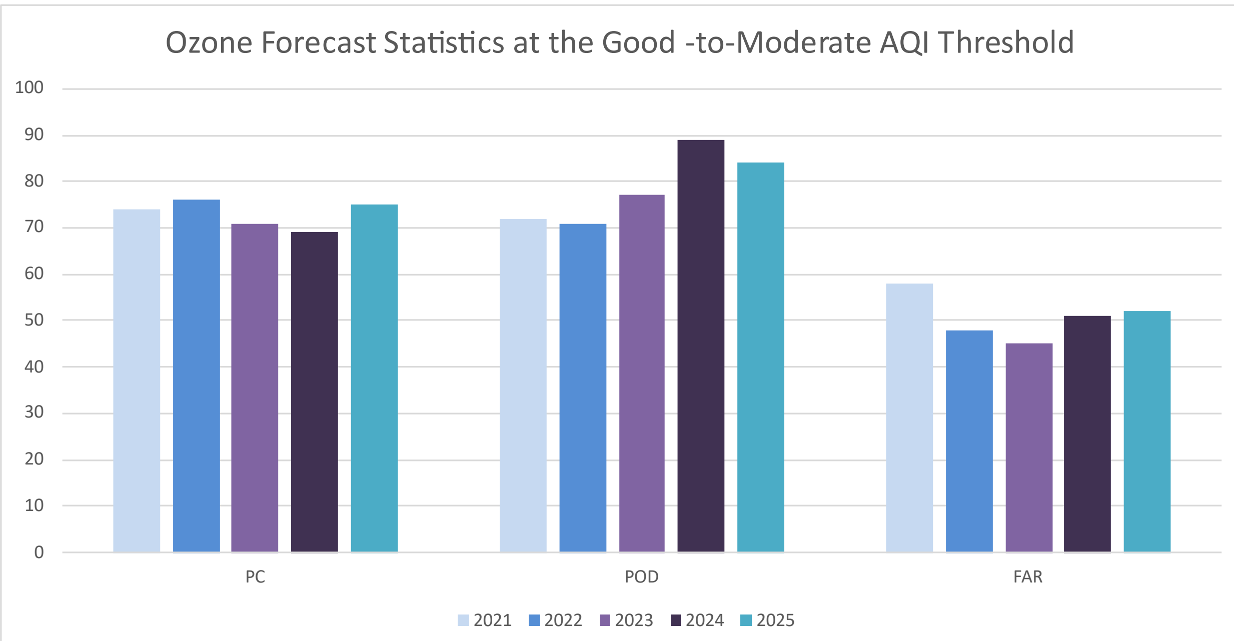

Figure 42. Percent Correct (PC), Probability of Detection (POD), and False Alarm Rate (FAR) at the Good-to-Moderate ozone AQI threshold for 2021–2025.

Forecast accuracy can also be assessed by calculating forecast bias and Mean Absolute Error (MAE), which is done by comparing the forecast ozone concentrations with observed ozone concentrations. Bias is the average difference between forecast and observed concentrations, with a positive bias indicating forecast concentrations that tend to be higher than the observed concentrations. Conversely, a negative bias indicates forecast concentrations that tend to be lower than the observed concentrations. MAE indicates the average absolute error between forecast and observed concentrations. A low MAE is indicative of accurate forecasts.

Table 9 lists the monthly forecast bias and MAE for all Spheros ozone forecasts during summer 2025 based on daily maximum 8-hour average ozone concentrations. For the May–September 2025 period, Spheros forecasts exhibited a bias of +4.9 ppb over observed ozone concentrations, with an

MAE of 7.4 ppb. Both the bias and MAE for ozone forecasts in summer 2025 were similar to those of summer 2024 but worse than those of summer 2021 through summer 2023. While Spheros strives to maintain forecast accuracy, the primary objective for next-day forecasts is to protect the public from harmful high-pollution events. This objective results in a consistent positive forecast bias. Table 10 contains a year-by-year breakdown of bias and MAE for Spheros next-day ozone forecasts.

Table 9. Spheros bias and MAE for next-day ozone forecasts for summer 2025.

Month	Bias (ppb)	Mean Absolute Error (ppb)
May	+0.6	5.5
June	+5.8	8.5
July	+6.2	8.4
August	+7.4	9.0
September	+4.9	5.6
Average	**+4.9**	**7.4**

Table 10. Spheros bias and MAE for next-day ozone forecasts for summer 2021 through 2025.

Year	Bias (ppb)	Mean Absolute Error (ppb)
2021	+4.7	6.8
2022	+4.2	7.1
2023	+3.8	6.5
2024	+4.8	7.4
2025	+4.9	7.4

During summer 2025, Spheros forecasts for ozone concentrations had their highest bias and MAE for the season in August. During that month, NOAA satellites analyzed smoke over Delaware on 21 of the month's 30 days. To account for smoke potentially enhancing ozone production, Spheros meteorologists issued several Moderate ozone AQI forecasts that were ultimately higher than the observed ozone AQI levels. Also contributing to the August high bias and MAE were low observed ozone concentrations on days with Good ozone AQI forecasts. For instance, on August 18, 23, and 24, next-day ozone forecasts and observed ozone concentrations were in the Good category. However, the forecasts were roughly 15–20 ppb higher than the observed ozone concentrations.

The lowest bias and MAE for next-day ozone forecasts in the 2025 summer forecast season occurred in May, where the average forecast bias was only +0.6 ppb over the observed ozone concentrations. Only one Moderate ozone AQI forecast was a false alarm during the month, and NOAA satellites analyzed smoke only twice in May, which reduced the threat for smoke-enhanced ozone formation.

4.1.2 2025 $PM_{2.5}$ Forecast Statistics

A comparison between Spheros next-day forecasts and observed $PM_{2.5}$ AQI levels in Delaware during summer 2025 is shown in **Figure 43**. Using the Good-to-Moderate threshold, Spheros next-day $PM_{2.5}$ forecasts in Delaware were correct 78% of the time, compared with 76% of the time during summer 2024.

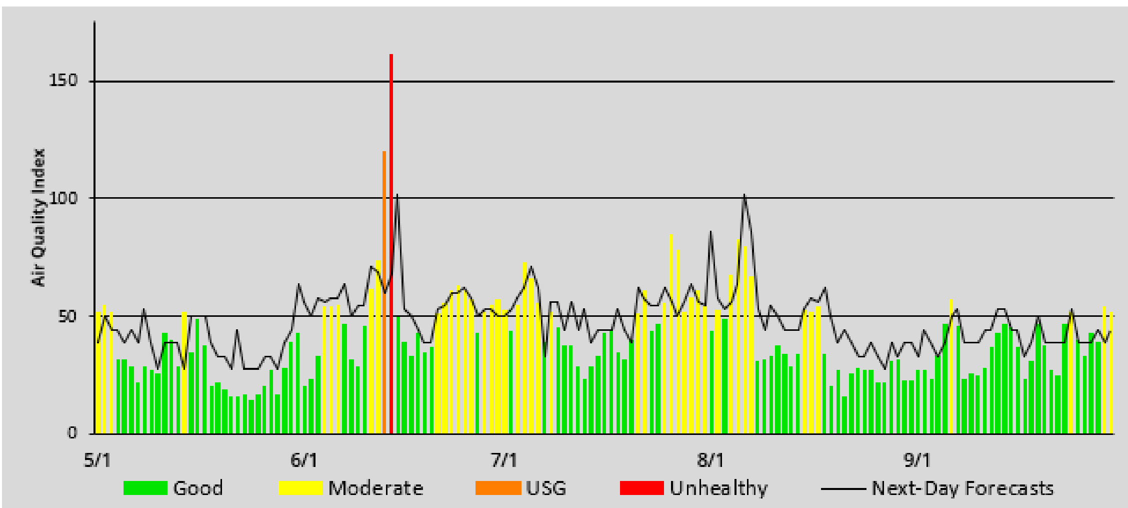

Figure 43. Daily observed May–September 2025 $PM_{2.5}$ levels in Delaware (bars) versus Spheros next-day forecasts (black line).

Moderate $PM_{2.5}$ AQI levels were observed on 47 days between May and September. Spheros issued Moderate $PM_{2.5}$ AQI level forecasts on 37 of these 47 days with Moderate $PM_{2.5}$ AQI levels, resulting in a POD of 79%. This season's POD was an improvement over last season's POD of 68%. Of the 61 Moderate AQI level forecasts issued for $PM_{2.5}$, there were 24 occurrences when the observed $PM_{2.5}$ AQI levels were lower than the forecast levels. As a result, the FAR for Moderate $PM_{2.5}$ forecasts was 39%. In summer 2024, the FAR was 33%. Summer 2025 was the second full season where $PM_{2.5}$ forecasts were issued daily during the May through September period. Therefore, a direct comparison with forecast statistics from 2021–2023 is not possible. **Figure 44** shows the PC, POD, and FAR for the last two forecast seasons for $PM_{2.5}$.

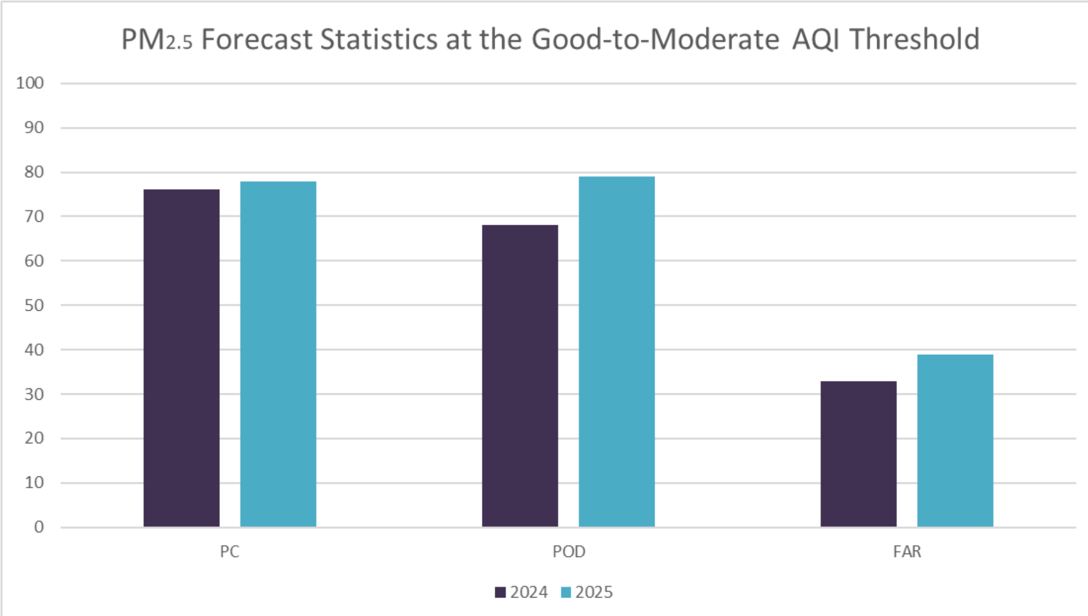

Figure 44. Spheros $PM_{2.5}$ next-day $PM_{2.5}$ AQI forecast statistics at the Good-to-Moderate AQI threshold.

Table 11 lists the monthly forecast bias and MAE for all Spheros next-day forecasts for $PM_{2.5}$ during summer 2025. For the season, next-day forecasts exhibited a bias of +1.3 µg/m^3 above observed $PM_{2.5}$ concentrations, with an MAE of 3.5 µg/m^3. In summer 2024, the bias for $PM_{2.5}$ next-day forecasts was +0.8 µg/m^3 with an MAE of 2.4 µg/m^3. While the summer 2025 metrics were slightly higher than those of the previous season, they also suggest that Spheros next-day forecasts for $PM_{2.5}$ were still accurate. June recorded the highest frequency of Moderate-or-higher $PM_{2.5}$ AQI levels, due largely to smoke. During this month, $PM_{2.5}$ next-day forecasts from Spheros meteorologists exhibited a bias of only +0.1 µg/m^3, marking the lowest bias of the summer forecasting season. However, the June MAE was 6.0 µg/m^3, which was the highest for the season. The highest forecast bias for $PM_{2.5}$ occurred in August, which also had a high frequency of analyzed smoke days, which factored into forecast decision-making.

Table 11. Spheros bias and MAE for next-day $PM_{2.5}$ forecasts for summer 2025.

Month	Bias (µg/m^3)	Mean Absolute Error (µg/m^3)
May	+1.6	2.4
June	+0.1	6.0
July	+0.7	3.4
August	+3.1	4.1
September	+0.9	1.7
Average	**+1.3**	**3.5**

4.2 Spheros Forecasts Versus Model Forecasts

To support air quality forecasting for the state of Delaware, Spheros meteorologists employ a variety of tools when issuing ozone and $PM_{2.5}$ forecasts. One such tool is NOAA's NAQFC model. This model updates twice daily, at 2:00 a.m. (06Z) and 8:00 a.m. (12Z) EDT (**https://airquality.weather.gov/**) and provides the following products utilized by Spheros meteorologists during forecasting operations:

- Raw and bias-corrected ozone predictions
- Raw and bias-corrected $PM_{2.5}$ predictions

The following sections provide an analysis of the accuracy of each model's next-day forecast output, based on the Wilmington, Delaware location; they also compare model performance with Spheros' next-day forecasts issued in summer 2025.

4.2.1 Comparison of Spheros Forecasts with 2025 NAQFC Ozone Forecasts

Table 12 lists the NAQFC next-day forecast bias and MAE for the raw and bias-corrected ozone product for Wilmington, Delaware, during the summer 2025 forecast season. Between May and September, both runs of the NAQFC raw model had a minimal high bias, while both runs of the NAQFC bias-corrected model exhibited a slight low bias. With respect to MAE, all model runs had a similar performance of around 7 ppb.

Table 12. May–September 2025 next-day ozone forecast model statistics for Wilmington, Delaware.

Model	Bias (ppb)	MAE (ppb)
NAQFC 06Z Raw	+0.3	7.2
NAQFC 06Z Bias-Corrected	-2.5	6.9
NAQFC 12Z Raw	+0.7	7.3
NAQFC 12Z Bias-Corrected	-2.3	6.7

Figures 45 and 46 compare the next-day forecast bias and MAE by month during the 2025 forecasting season. These figures include the modeled ozone predictions from NAQFC and Spheros' next-day ozone forecasts (blue bars at the left of each grouping). The seasonal averages for bias and MAE during the May-September 2025 period appear at the far right of each figure.

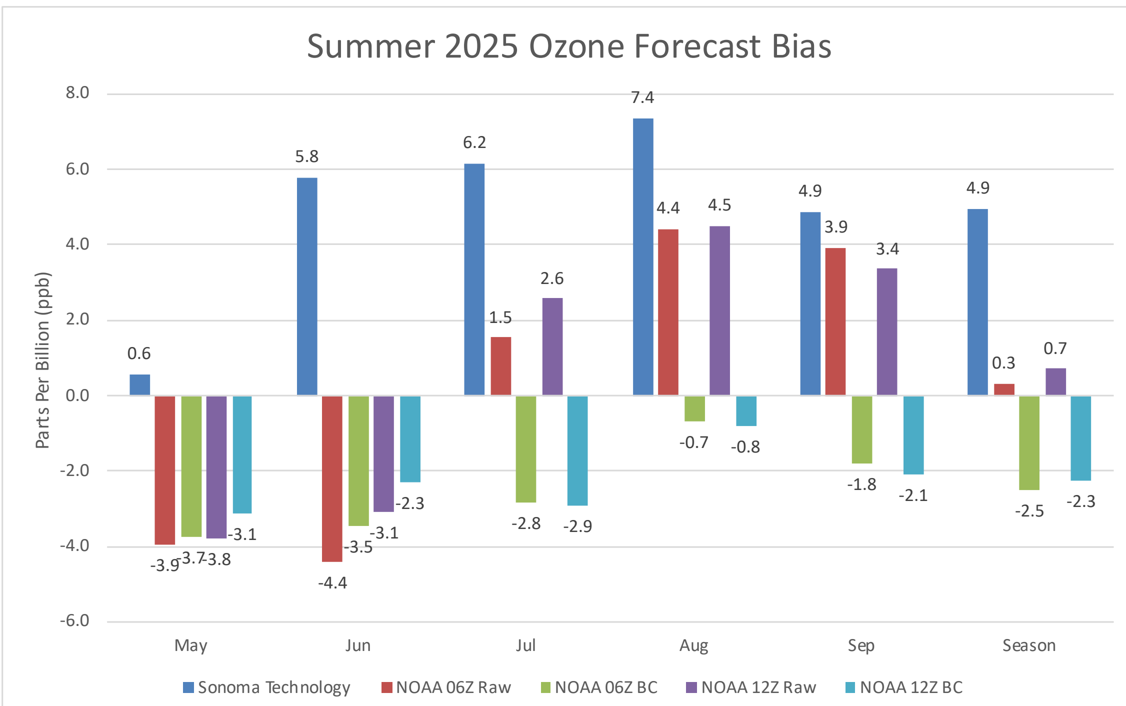

Figure 45. Monthly NOAA NAQFC model ozone forecast for Wilmington, Delaware, and Spheros next-day ozone forecast bias during the 2025 summer forecast season. Sonoma Technology is now Spheros Environmental.

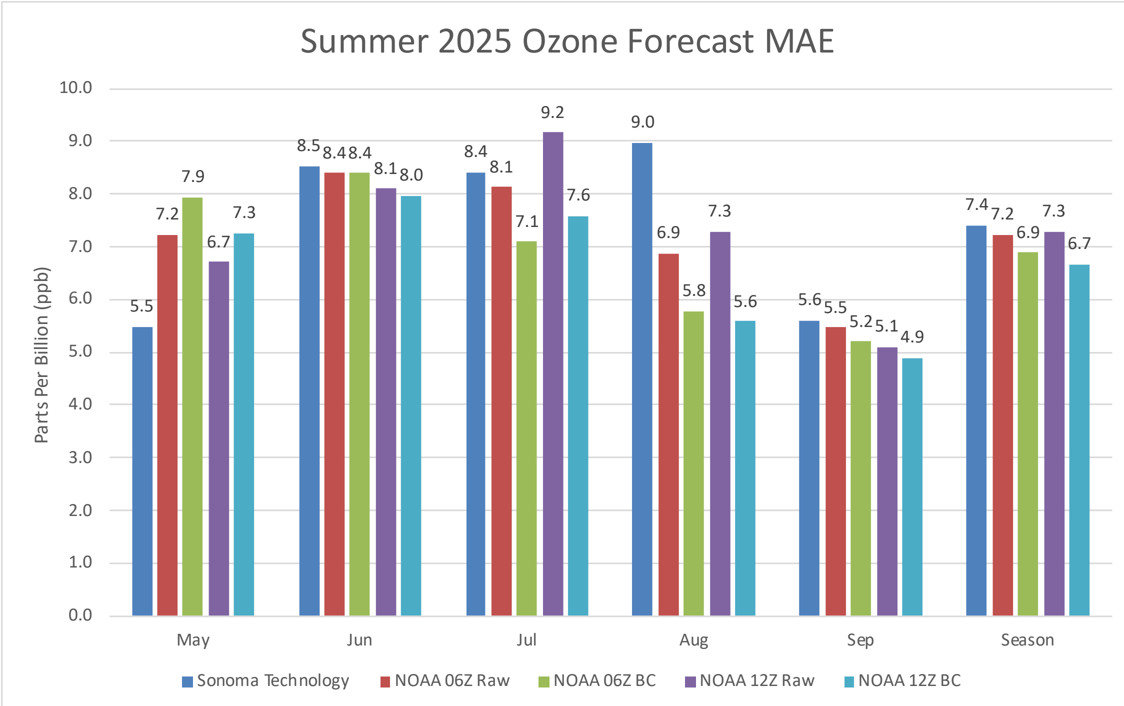

Figure 46. Monthly NOAA NAQFC model ozone forecast for Wilmington, Delaware, and Spheros next-day ozone forecast MAE during the 2025 summer forecast season. Sonoma Technology is now Spheros Environmental.

In the 2024 forecast season, small positive biases existed every month except for June for all four NAQFC ozone model runs. For the 2025 forecast season, biases for the NAQFC ozone model recorded more variation by the month and model run. The raw and bias-corrected NAQFC ozone models were biased low in May. On the other hand, Spheros ozone forecasts performed the best in May, with next-day forecasts having a marginal high bias. The following month, Spheros ozone forecasts recorded a high bias of +5.8 ppb over ozone observations, while all NAQFC ozone forecasts were biased low versus ozone observations. Spheros' high bias in its next-day ozone forecasts continued during the July through September period. During this same time, NAQFC bias-corrected ozone model predictions remained lower than observed ozone concentrations. However, this low bias was reduced in August, marking the bias-corrected model's best performance of the season. For the raw NAQFC ozone model, forecasts from July to September were biased high. July's biases ranged from +1.5 ppb over observations (06Z raw) to +2.6 ppb over observations (12Z raw). These biases were the best out of any month of the forecast season for the raw NAQFC model.

When comparing all forecasts across the entire 2025 forecasting season, Spheros forecasts had the highest bias, while the NAQFC bias-corrected model runs produced the lowest bias. The NAQFC raw model runs exhibited the best performance for the season, with biases ranging from +0.3 ppb over observations with the 06Z raw model to +0.7 ppb over observations with the 12Z raw model. The MAE for all forecasts this season was generally around 7 ppb. As noted in Section 4.2, next-day forecasts from Spheros often result in a high forecast bias, due to considerations made for protecting public health and decision-making support for air quality outreach programs in Delaware.

4.2.2 Comparison of Spheros Forecasts with 2025 NAQFC $PM_{2.5}$ Forecasts

Table 13 lists the NAQFC next-day forecast bias and MAE for the raw and bias-corrected $PM_{2.5}$ products for Wilmington, Delaware, during the May through September 2025 period. The 06Z and 12Z raw NAQFC model runs each had a bias at or near +1.5 µg/m^3 over observations, and each run had an identical MAE of 4.0 µg/m^3. For the 06Z and 12Z bias-corrected NAQFC models, both runs had marginal low biases at or around -0.3 µg/m^3 under observations, along with an identical MAE of 3.7 µg/m^3. These metrics suggest good performance from all four NAQFC model runs in their next-day forecasts for $PM_{2.5}$.

Table 13. May-September 2025 next-day $PM_{2.5}$ NAQFC forecast model statistics for Wilmington, Delaware.

Model	Bias (µg/m^3)	MAE (µg/m^3)
NAQFC 06Z Raw	+1.4	4.0
NAQFC 06Z Bias-Corrected	-0.3	3.7
NAQFC 12Z Raw	+1.5	4.0
NAQFC 12Z Bias-Corrected	-0.2	3.7

Figures 47 and 48 compare the NAQFC $PM_{2.5}$ next-day forecast bias and MAE for the May through September 2025 period. These figures also compare model performance with the $PM_{2.5}$ next-day forecasts Spheros issued (blue bars at the left of each grouping). The seasonal averages for bias and MAE during the May through September 2025 period are shown at the far right of each figure.

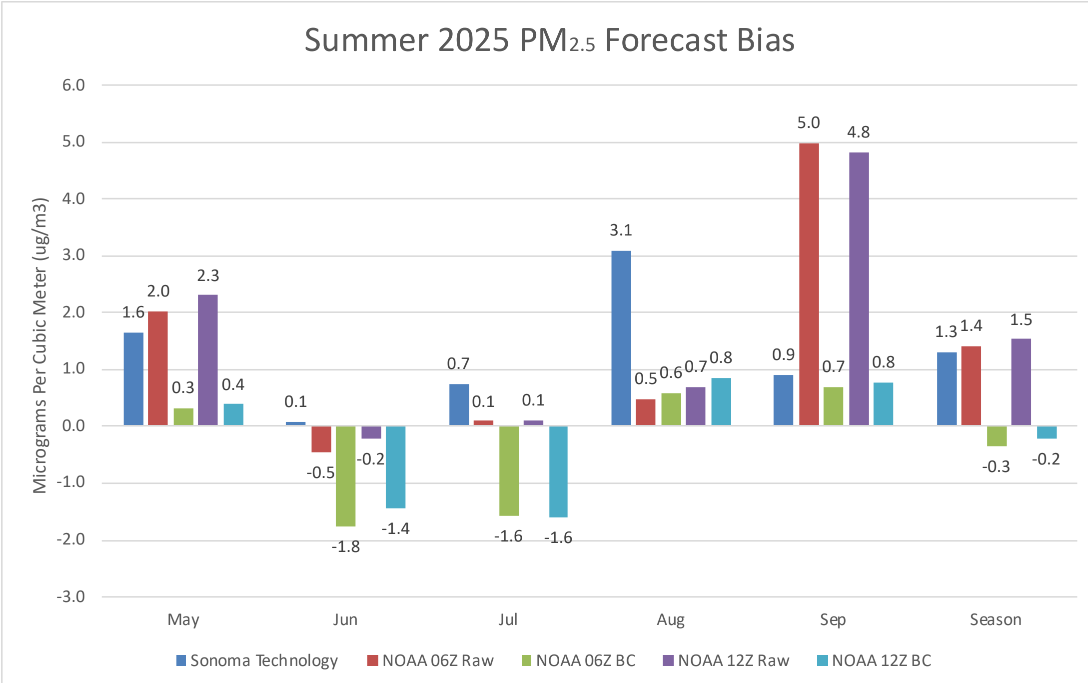

Figure 47. Monthly NOAA NAQFC model $PM_{2.5}$ forecast for Wilmington, Delaware, and Spheros next-day $PM_{2.5}$ forecast bias during the 2025 summer forecast season. Sonoma Technology is now Spheros Environmental.

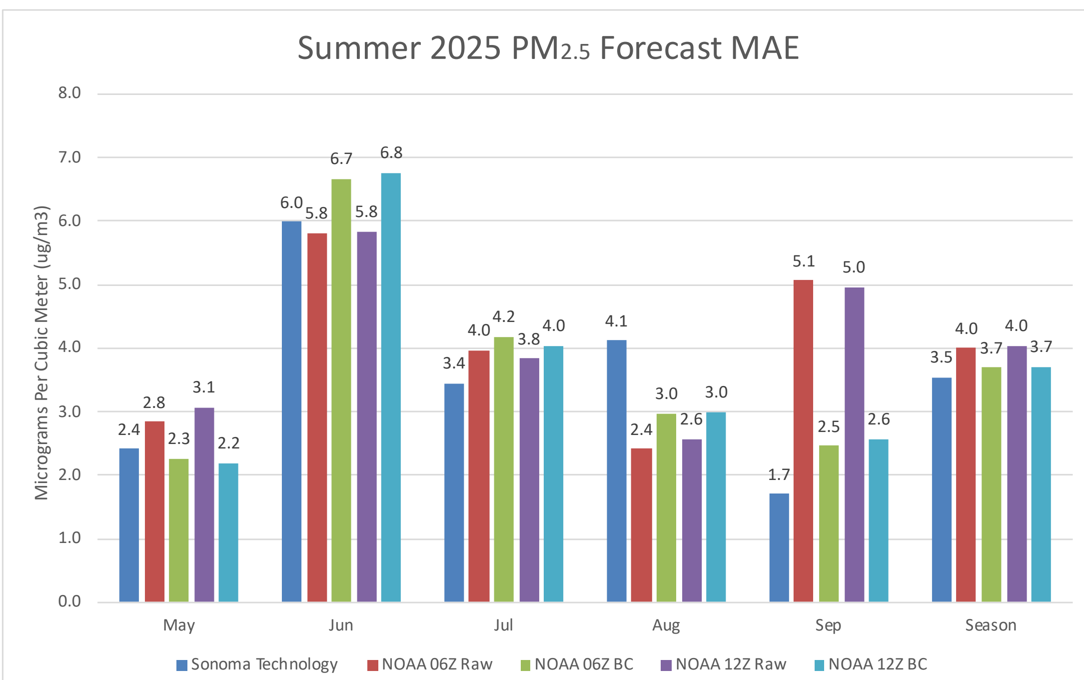

Figure 48. Monthly NOAA NAQFC model $PM_{2.5}$ forecast for Wilmington, Delaware, and Spheros next-day $PM_{2.5}$ forecast MAE during the 2025 summer forecast season. Sonoma Technology is now Spheros Environmental.

Forecast accuracy for the NAQFC bias-corrected $PM_{2.5}$ model was at its best in May, when a minimal high bias was recorded and the MAE was around +2 µg/m^3. For the NAQFC raw and Spheros forecasts in May, biases were higher. However, the May MAE for Spheros and both NAQFC bias-corrected model runs were similar, suggesting accurate forecasts for all three sets of predictions. In June, forecast biases for Spheros and NAQFC raw forecasts were near 0 µg/m^3. While these biases were minimal, the June MAE for Spheros and NAQFC raw forecasts was around 6.0 µg/m^3, indicating a decrease in forecast accuracy. For the NAQFC bias-corrected model runs in June 2025, forecasts were lower than observations, while MAE was near 7 µg/m^3. The high MAE in all June forecasts likely relates to the models and Spheros meteorologists accounting for the frequent transport of smoke into the state, which was discussed in Section 2.4.

The low bias for the NAQFC bias-corrected model runs continued in July, with each model run generally around -1.6 µg/m^3 lower than observations. The raw NAQFC model predictions held nearly no bias in July, marking their best performance of the 2025 summer forecasting season. Meanwhile, the Spheros forecasts had a high bias in July of +0.7 µg/m^3 over observations. Forecast accuracy improved in July versus the previous month, as MAEs for all forecasts were lower than what was recorded in June. In July, Spheros forecasts exhibited a lower MAE than any NAQFC model forecast.

Both forecasts and model predictions in August and September were higher than the $PM_{2.5}$ observations; however, the difference varied in magnitude. The NAQFC bias-corrected model runs exhibited a slight high bias each month. Forecast biases for the NAQFC raw model runs were also biased slightly higher than observations in August but sharply rose in September to around +5 µg/m^3 above observations. Spheros forecast biases ranged from +3.1 µg/m^3 over observations in August to +0.9 µg/m^3 over observations in September. MAEs for all NAQFC forecasts were around 2.5–3.0 µg/m^3 for August. MAEs for the bias-corrected models remained similar in September but increased to around 5.0 µg/m^3 for the NAQFC raw models. Spheros' forecast MAE in August was 4.1 µg/m^3 but improved to 1.7 µg/m^3 in September. While $PM_{2.5}$ bias and MAE varied by month and by model run, seasonal averages for bias and MAE indicate all $PM_{2.5}$ forecasts for Delaware were accurate.

5. Seasonal Forecast Review and Outlook

5.1 Review of Spheros' Summer 2025 Outlook

Each year, Spheros meteorologists use several methods to make long-term predictions of temperature and precipitation anomalies for the upcoming summer and assess how these anomalies might impact air quality in Delaware in June, July, and August. The methods include a review of long-range meteorological forecast model output, an analysis of summer temperature and precipitation trends in the Mid-Atlantic, and a comparison of seasons with similar El Niño-Southern Oscillation (ENSO) conditions. In addition, the official seasonal climate forecast from NOAA's Climate Prediction Center (CPC) is reviewed for comparison with the information provided by the other methods. Furthermore, Spheros meteorologists review forecast upper-level weather patterns and ambient drought conditions across Canada to discern the potential for the influence of wildfire smoke on summer air quality.

5.1.1 Summer 2025 Temperature Forecast

Both the Canadian Seasonal to Inter-annual Prediction System (CanSIPS) model and European Centre for Medium Range Weather Forecasting (ECMWF) seasonal weather model agreed that temperatures were anticipated to be above average in Delaware during summer 2025. Temperature trends also indicated warming summers along the Mid-Atlantic over the last decade, raising the likelihood for above-average temperatures. In addition, after a weak La Niña, neutral ENSO conditions were forecast to develop over the summer. This ENSO pattern has historically led to above-average summer temperatures in Delaware. Finally, CPC's official temperature forecast for summer 2025 indicated a good chance of above-average temperatures. Given the agreement among these methods and products, Spheros meteorologists predicted above-average temperatures for Delaware over the summer.

5.1.2 Summer 2025 Precipitation Forecast

The precipitation forecast was also for above-average precipitation for summer 2025. While ENSO-similar summers resulted in near-average precipitation over the region, forecast models and trends agreed on the potential for increased rainfall over the region. In addition, CPC's forecast for the summer indicated a 33–40% chance of above-normal precipitation, lending further support to the above-average precipitation forecast.

5.1.3 Summer 2025 Smoke and Air Quality Forecast

The smoke forecast for summer 2025 called for near-average smoke production across Canada. One of the factors considered in the forecast was improved Canadian drought conditions compared with the prior season. In addition, long-range forecast models were predicting the potential for a cool and wet spring, possibly delaying seasonal fuel moisture declines. Furthermore, as of late January, near- to above-average winter snowpack further indicated the potential for drought conditions to remain minimal during the spring. Taking these factors into consideration, Spheros meteorologists did not anticipate a significant increase in $PM_{2.5}$ or ozone due to long-range transport of wildfire smoke over the summer. Given the smoke forecast and the forecast for increased precipitation over the Mid-Atlantic, AQI levels were forecast to be near average in Delaware during summer 2025.

5.1.4 Summer 2025 Observed Temperatures

The observed temperature anomalies for the United States during summer 2025 are shown in **Figure 49**.

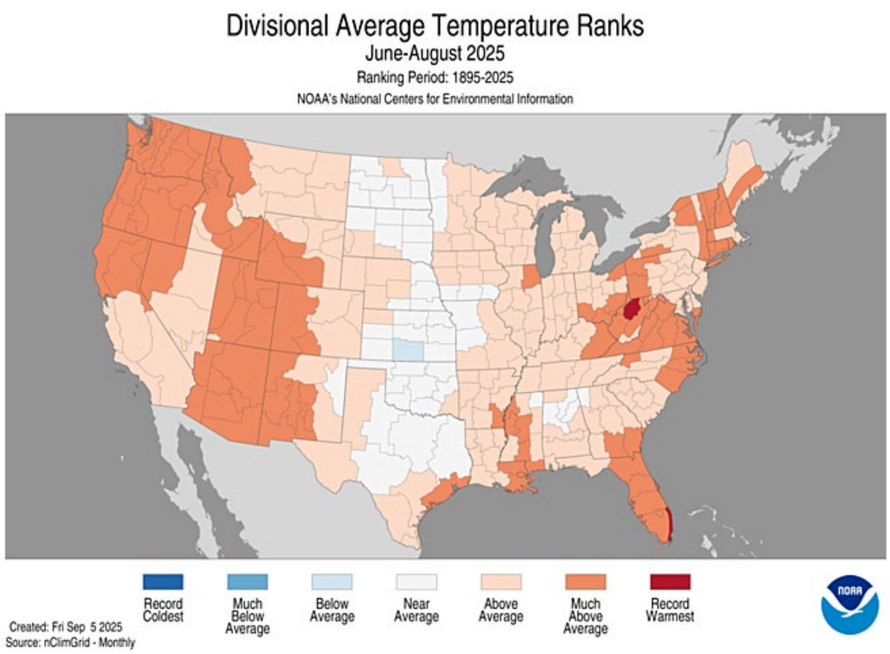

Figure 49. Temperature anomalies in summer 2025. Source: NOAA/NCEI.

Figure 49 shows that Delaware's average temperatures during summer 2025 were above average, with much-above-average warmth just southwest of the state. Similar to the previous season, these warm conditions were partly in response to above-average sea surface temperatures in the western Atlantic, as well as anomalous high-pressure aloft that peaked over the region in June and July.

These conditions were consistent with the forecast for above-average temperatures in Delaware for summer 2025. Note that ENSO-neutral conditions were observed as expected over the summer and remained in a neutral phase into the fall of 2025.

5.1.5 Summer 2025 Observed Precipitation

The observed precipitation anomalies for the United States during summer 2025 are shown in **Figure 50**.

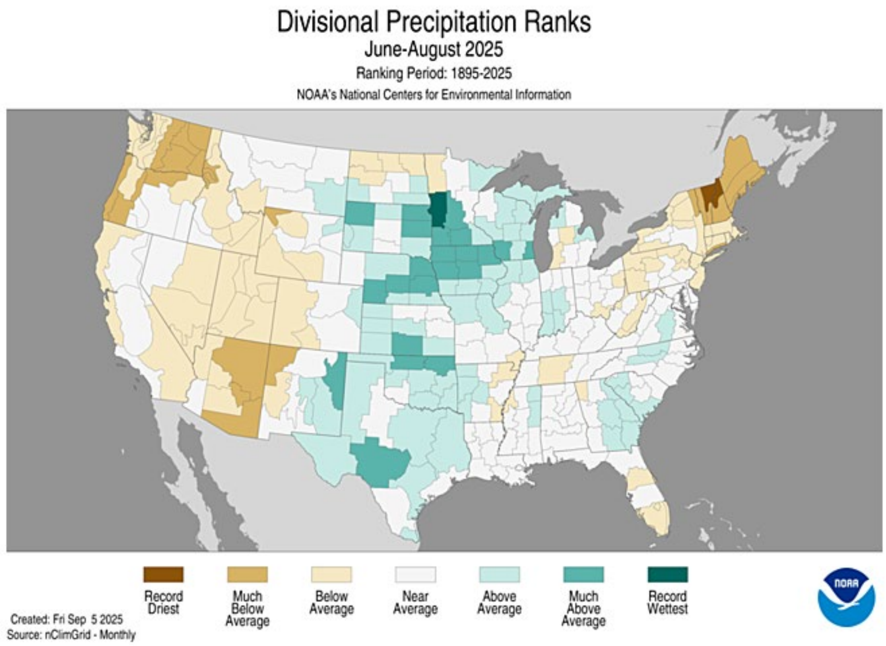

Figure 50. Precipitation anomalies for summer 2025. Source: NOAA/NCEI.

Delaware's precipitation during summer 2025 was near average. However, above-average precipitation was observed just southwest of the region. These conditions were slightly drier than expected in Spheros' precipitation forecast for Delaware in summer 2025.

5.1.6 Summer 2025 Observed Smoke and Air Quality

Canada experienced another active wildfire season in 2025, with the Canadian Interagency Forest Fire Centre reporting over 8.9 million hectares (just over 22 million acres) burned through November 18, 2025. While this figure is less than the recent record set in 2023, these numbers put Canada's 2025 burned area at the second highest since 1983 (**Figure 51**).

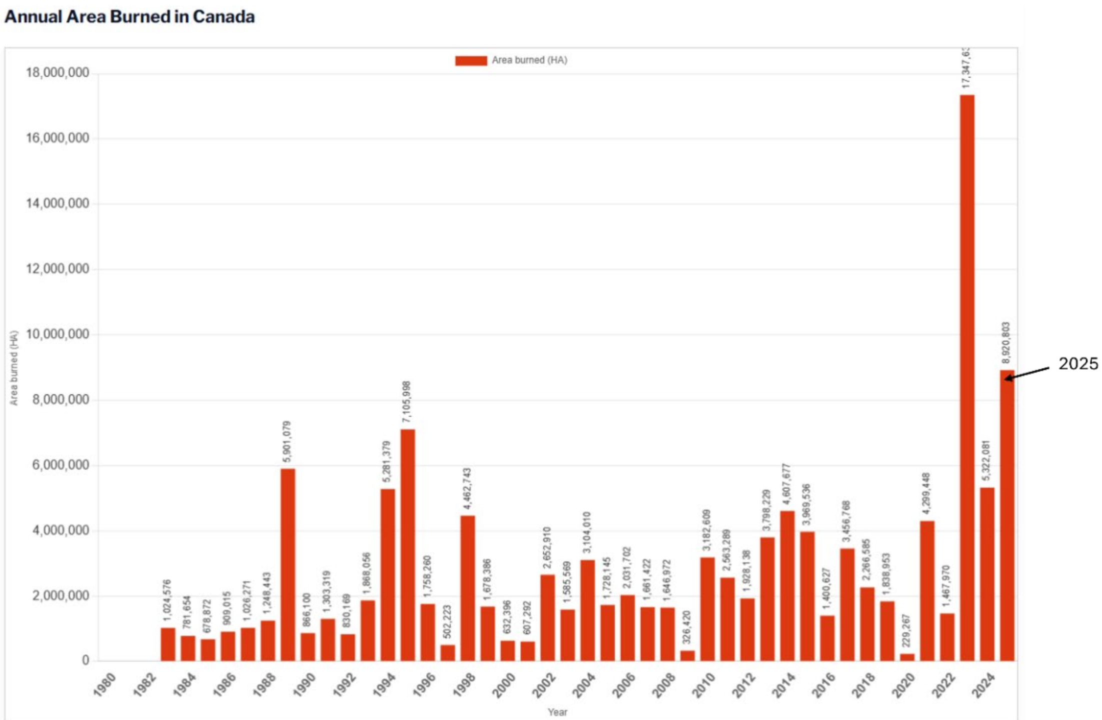

Figure 51. Annual satellite-estimated cumulative number of hectares burned by wildfires in Canada. Source: CIFFC.

As shown in **Figure 52**, most of these fires occurred in northwestern and central Canada, which kept the worst Canadian smoke impacts far removed from the mid-Atlantic.

Figure 52. Canadian wildfire activity during the 2025 fire season. Source: Canadian Wildland Fire Information System.

Furthermore, the dominant mid-level weather pattern over the summer featured 700-mb height contours oriented from west-northwest to east-southeast over northeastern North America. This pattern indicates west-northwesterly mid-level winds parallel to those height contours, which directed much of the dense smoke into the Great Lakes region and eastern Canada (**Figure 53**).

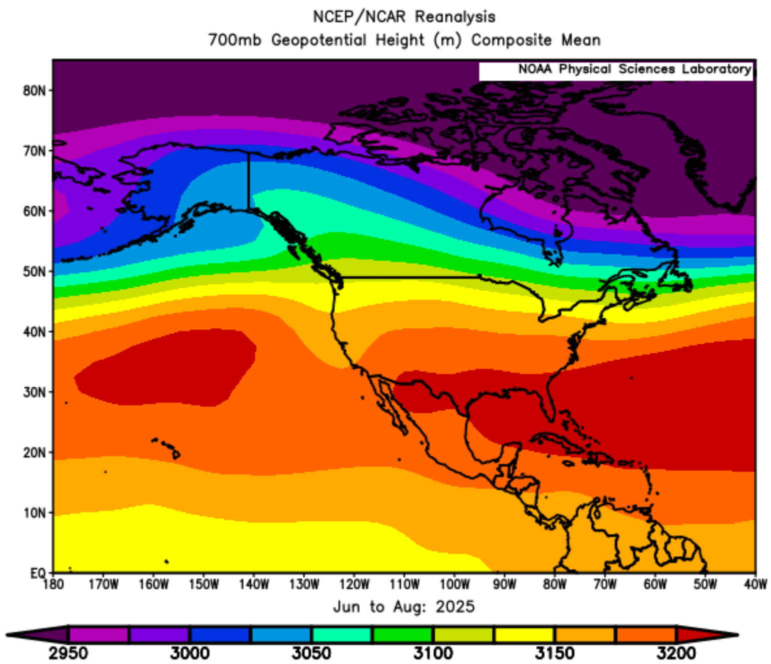

Figure 53. Average height contours of the 700-mb pressure level indicate west-northwesterly mid-level winds over the most active fire regions in northwestern and central Canada during summer 2025. Source: NOAA's Physical Sciences Laboratory.

As a result, even though the Canadian fire season was the second most active on record, the number of days with HMS-analyzed smoke over Delaware decreased compared with the last two seasons (**Section 2.4**). These conditions led to an overall reduction in the contribution of smoke to $PM_{2.5}$ and ozone concentrations in the Mid-Atlantic during summer 2025. The reduction in smoke impacts matched expectations from the summer outlook. However, the reason for the reduction was more related to the dominant wind pattern and fire locations versus a reduction in overall Canadian fire activity.

5.2 Climate Prediction Center Summer Outlook for 2026

To gauge the potential for ozone development during the upcoming 2026 summer season, Spheros meteorologists reviewed seasonal forecasts by NOAA's CPC, composites of temperature and precipitation anomalies for years with similar ENSO conditions, and model output from seasonal weather models. Recent trends in summer temperatures and precipitation were also considered. This analysis focuses on the forecast for June, July, and August 2026, as these months represent the peak of ozone season in Delaware.

CPC's forecasts for temperature and precipitation anomalies for summer 2026 are shown in **Figures 54 and 55** below.

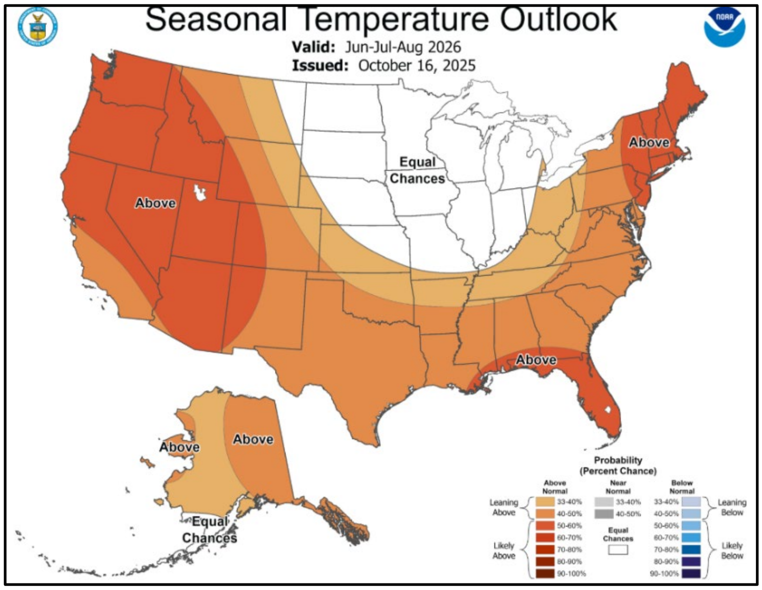

Figure 54. Forecast probability of surface temperature anomalies for June, July, and August 2026. Source: CPC.

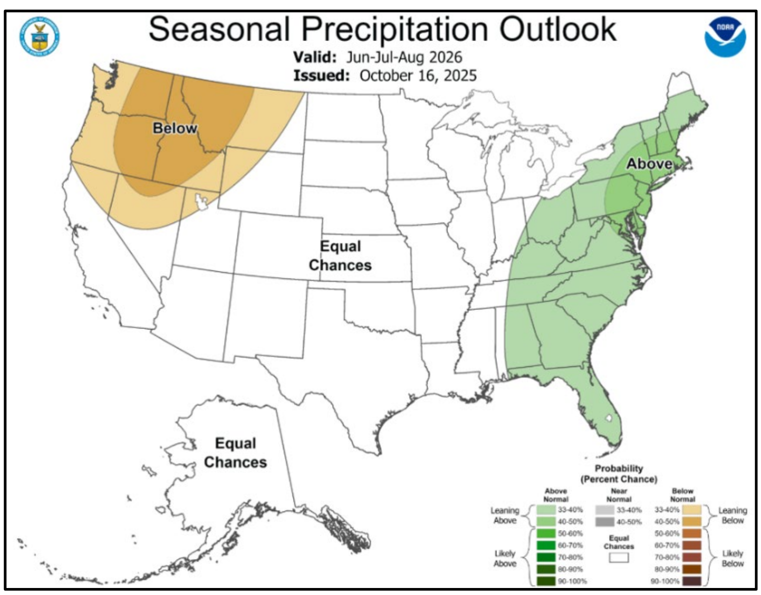

Figure 55. Forecast probability of precipitation anomalies for June, July, and August 2026. Source: CPC.

Figures 54 and 55 indicate that the CPC is predicting a 40–50% chance of above-average temperatures and a 40–50% chance of above-average precipitation in Delaware for summer 2026. The following sections detail how other data sources compare with the official forecast and provide a brief discussion of how meteorology could impact ozone and $PM_{2.5}$ in Delaware in summer 2026.

5.3 El Niño Southern Oscillation

CPC's ENSO outlook is predicting a transition from weak La Niña conditions during the winter of 2025–2026 to ENSO-neutral conditions during the spring and summer of 2026. Although ENSO is just one of many variables when it comes to global oceanic and atmospheric circulations, current ENSO conditions and forecasts can provide useful insights into how weather conditions may respond over the continental United States. Spheros meteorologists investigated how temperature and precipitation anomalies were impacted by recent occurrences of ENSO conditions that were most similar to the forecast for the spring and summer of 2026. Over the last 30 years, similar conditions occurred in 1996, 2001, 2006, 2009, 2012, 2013, 2014, 2017, 2018, and, most recently, 2025. **Figures 56 and 57** show composites of the temperature and precipitation anomalies that occurred during those analogous summers.

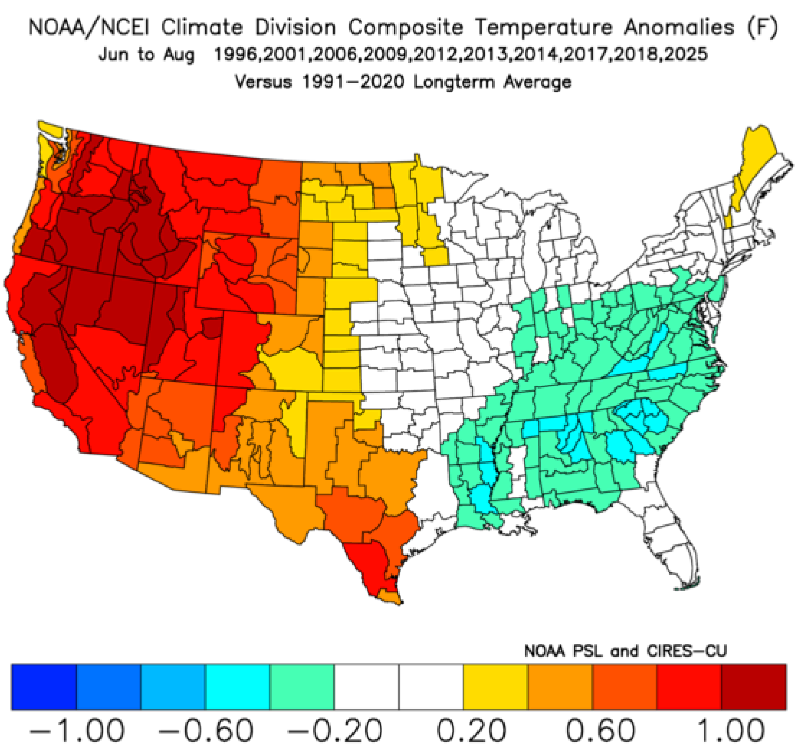

Figure 56. Temperature anomalies (°F) for ENSO-similar summers. Source: NOAA PSL and CIRES-CU.

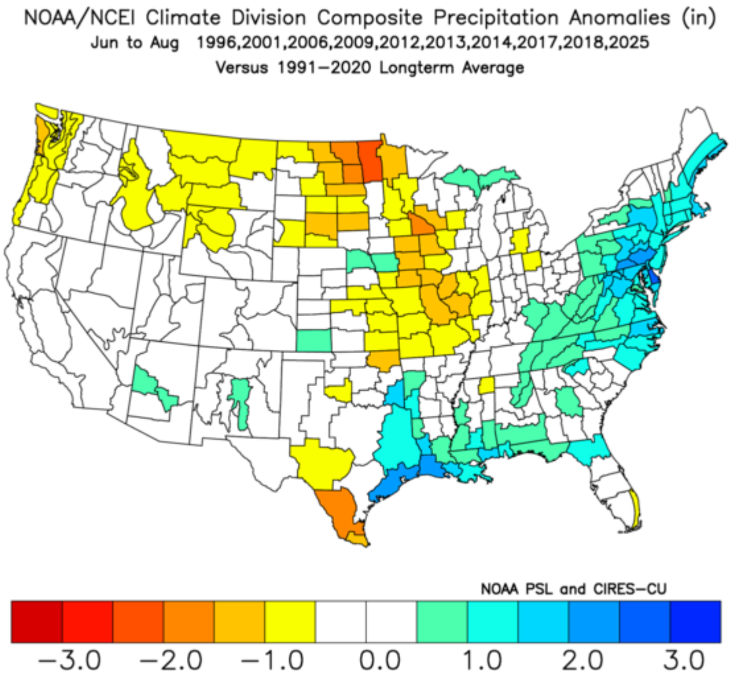

Figure 57. Precipitation anomalies (inches) for ENSO-similar summers. Source: NOAA PSL and CIRES-CU.

These figures reveal that summers with ENSO conditions similar to the ENSO forecast for 2026, on average, had near to slightly-below-normal temperatures and above-normal precipitation in the Mid-Atlantic region. In addition to temperature and precipitation anomalies, the average heights of the 700-mb pressure level were also plotted for these summers to determine what mid-level wind patterns could emerge during the summer of 2026 (**Figure 58**).

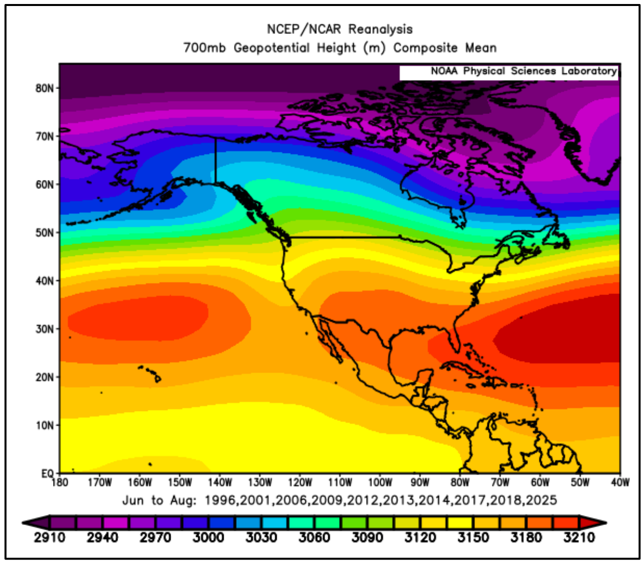

Figure 58. Average heights of the 700-mb pressure level during summers with ENSO conditions similar to the 2026 forecast.

On average, during the ENSO-similar summers there was a stronger ridge of high pressure at 700-mb over the Rockies and a deeper trough of low pressure along the East Coast than what was observed last season. Depending on Canadian wildfire smoke production, if this wind pattern develops during the summer of 2026, it could be more conducive to Canadian smoke transport into the Mid-Atlantic region. It also helps to explain the temperature and precipitation anomalies during the ENSO-similar summers, with warmer and drier conditions underneath the western ridging, and cooler, wetter conditions coinciding with the eastern trough.

Although ENSO conditions and forecasts are an important component of the summer outlook, forecast models can resolve additional complexity between the different atmospheric systems that affect weather patterns around the globe. The following section examines the seasonal forecasts from climate models to see how they compare with the overall forecast.

5.4 Model Forecasts

The seasonal temperature and precipitation forecasts from the CanSIPS model are shown in **Figures 59 and 60**. The CanSIPS model is an ensemble of two climate models developed by the Canadian Centre for Climate Modelling and Analysis and the Canadian Meteorological Centre. The model considers some of the complex interactions among the atmosphere, oceans, ice, and land surfaces across the globe to produce seasonal, long-range forecasts.

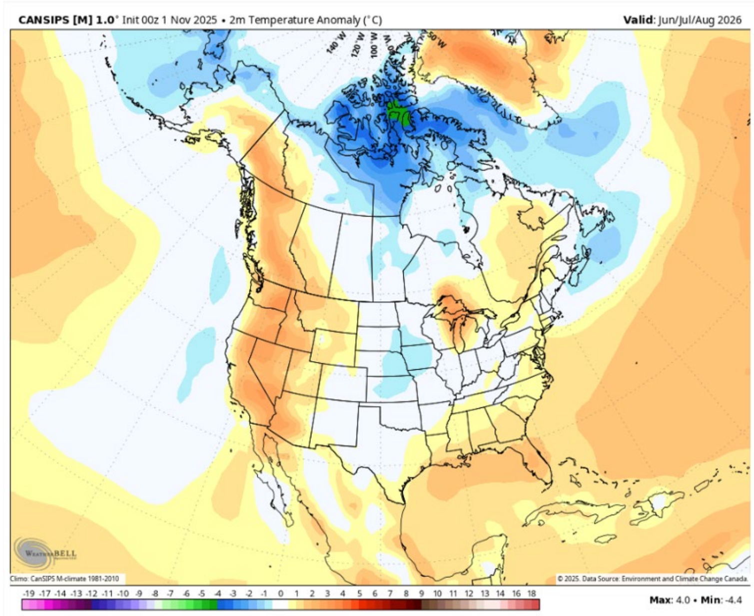

Figure 59. CanSIPS forecast temperature anomalies (°C) for June–August 2026. Source: WeatherBell.

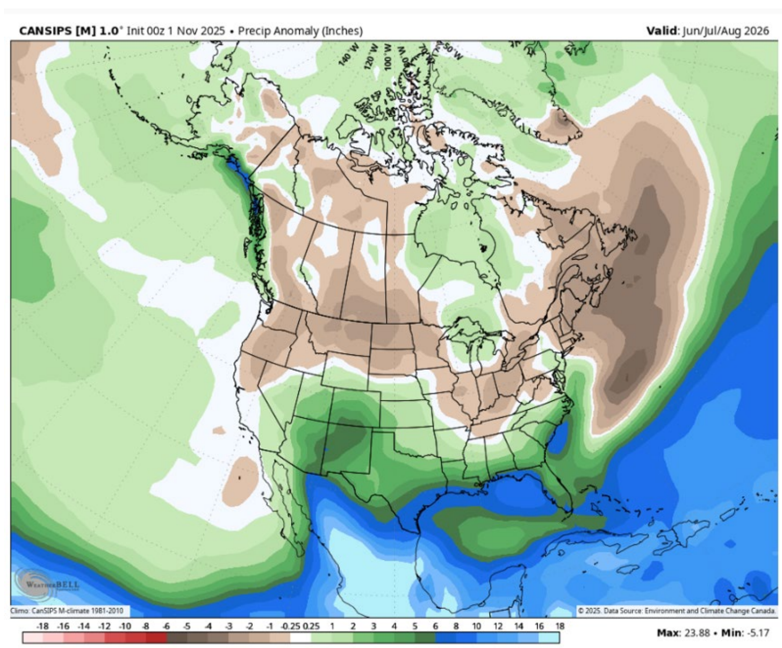

Figure 60. CanSIPS forecast precipitation anomalies (inches) for June–August 2026. Source: WeatherBell.

Similar to the CPC's forecast, the CanSIPS model is forecasting above-average temperatures for Delaware during summer 2026. Meanwhile, the precipitation forecast from CanSIPS for the Mid-

Atlantic is also similar to the CPC's forecast, with the potential for slightly above-average rainfall in Delaware.

Temperature and precipitation outlooks are also available from the ECMWF seasonal weather model. However, as of the writing of this outlook, forecasts were only available through May 2026. As a result, forecast output from the ECMWF model was used to investigate the temperature and precipitation forecast for the spring to give insights into what conditions might look like heading into the summer. **Figures 61 and 62** show the ECMWF temperature and precipitation outlook for March, April, and May 2026.

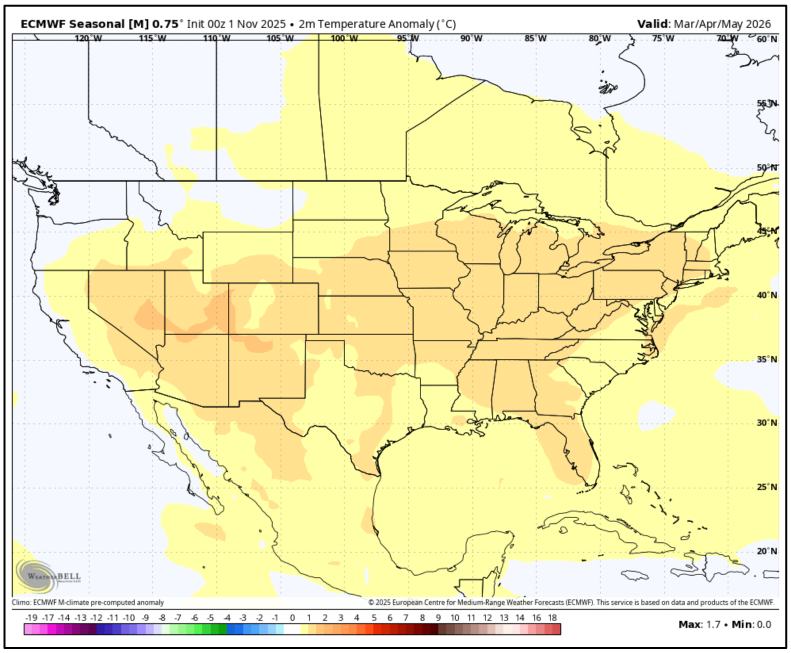

Figure 61. ECMWF temperature outlook for March, April, and May 2026. Source: WeatherBell.

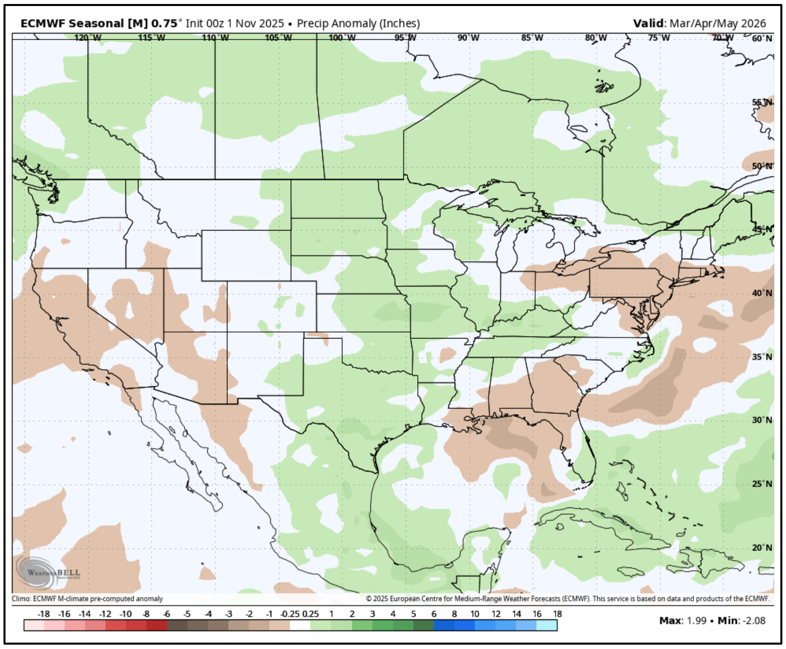

Figure 62. ECMWF precipitation outlook for March, April, and May 2026. Source: WeatherBell.

Figures 61 and 62 show that the ECMWF model is forecasting above-normal temperatures and slightly below-normal precipitation during the spring over the Mid-Atlantic. Farther north, it also depicts above-normal temperatures across eastern Canada during the spring, along with slightly above-normal precipitation in that region. These patterns have important implications for potential Canadian smoke impacts, which are discussed in **Section 5.6**.

5.5 Trends in Summer Temperatures and Precipitation

Another factor to consider in seasonal weather predictions is recent weather trends compared with climatological norms. The CPC produces maps of temperature and precipitation trends for 3-month periods throughout the year. Temperature trends reflect the difference between the average temperatures during a selected 3-month period over the last 10 years and the 30-year temperature climatology from 1981–2010. Precipitation trends reflect the difference between the average precipitation during a selected 3-month period over the last 15 years and the 30-year precipitation climatology from 1981–2010. The trend maps are shown in **Figure 63**.

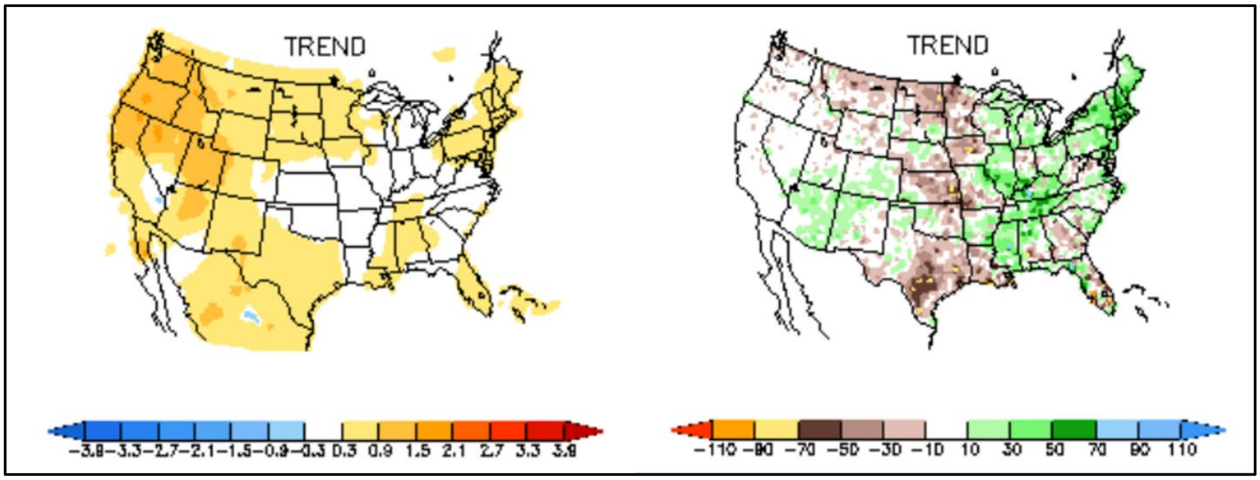

Figure 63. Recent trends in temperature in ˚C (left) and precipitation in millimeters (right) for June, July, and August. The recent trend is estimated by the Optimal Climate Normal (OCN) of Huang et al. (1996).[2]

Trends in summertime temperatures and precipitation show that, in general, temperatures exhibit a slight tendency toward warming from the Northeast into the Mid-Atlantic. In addition, summertime precipitation is increasing in many areas east of the Mississippi River.

5.6 Canadian Smoke Factors

Smoke can also be an important factor in AQI levels in Delaware during the summer months; smoke can both enhance ozone production and increase concentrations of $PM_{2.5}$. Previous seasons have shown that Canadian wildfire smoke can increase above average seasonal levels when spring temperatures are above average, or abnormally dry antecedent conditions exist as summer approaches. **Figure 64** shows forecast temperature and precipitation anomalies for the period from March–May 2026, as forecast by the ECMWF and CanSIPS models.

[2] Huang et al. "Long-lead seasonal temperature prediction using optimal climate normals." Journal of Climate, vol. 9, no. 4, Apr. 1996.

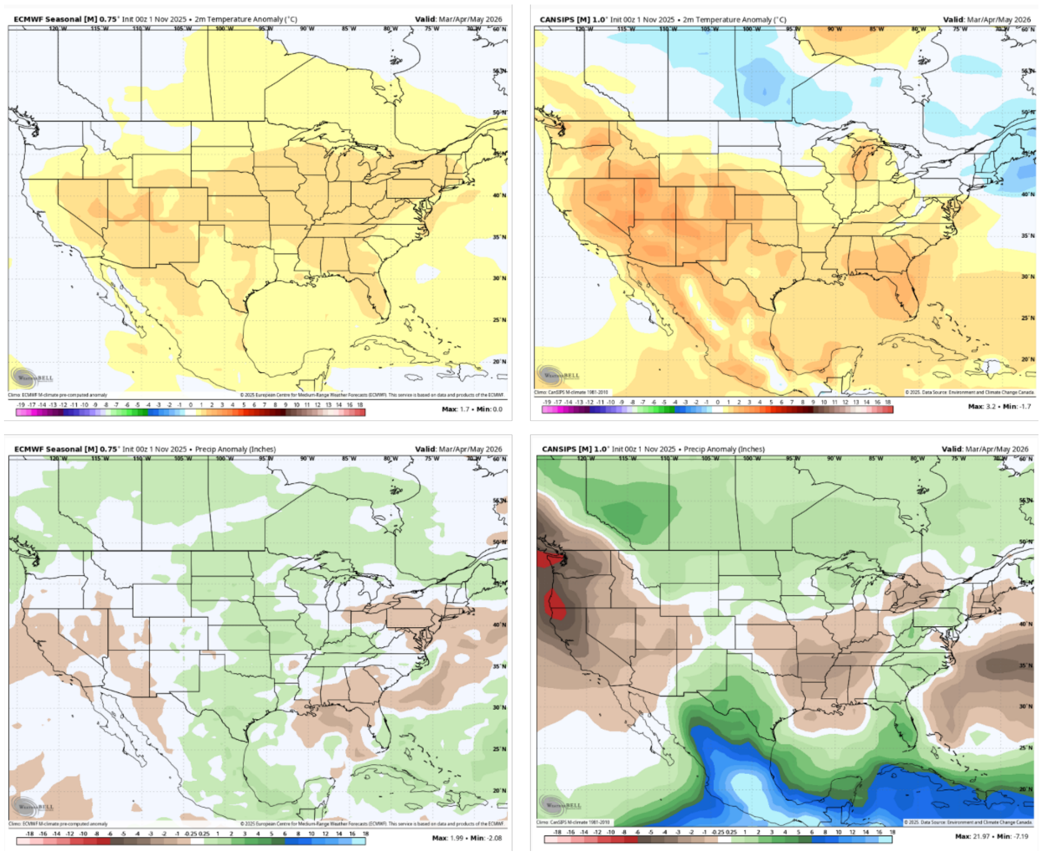

Figure 64. Forecast surface temperature (top) and precipitation (bottom) anomalies from March–May 2026 from the ECMWF model (left) and the CanSIPS model (right). Source: WeatherBell.

The spring temperature forecast for Canada is mixed, with slightly above-average temperatures forecast by ECMWF and slightly below-average temperatures forecast by CanSIPS. However, both models are predicting slightly above-average precipitation across Canada during the spring. Unfortunately, this precipitation may not be sufficient to alleviate the ongoing drought. As shown in **Figure 65**, fall drought conditions were generally worse across Canada in February 2026 compared with February 2025.

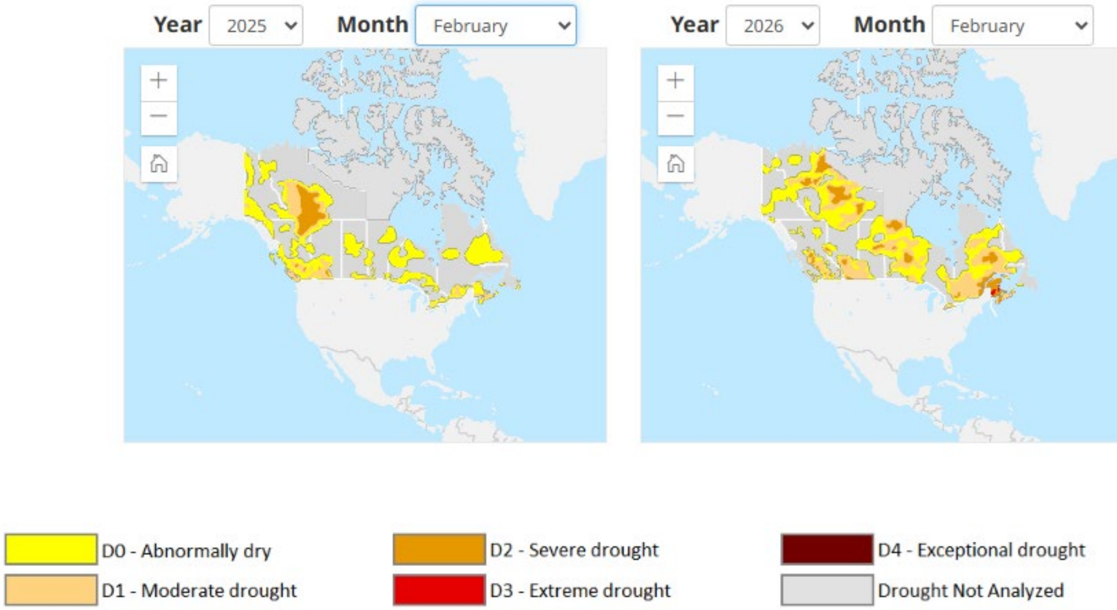

Figure 65. Comparison of drought conditions in Canada in February 2025 (left) and February 2026 (right).

For Mid-Atlantic air quality, the most concerning aspect of the drought developing across Canada is the widespread moderate-to-severe drought observed in southeastern Ontario and Quebec. If drought conditions persist into the summer, fire activity could increase in areas where the northwesterly mid-level winds discussed in **Section 5.3** could periodically transport wildfire smoke into the Mid-Atlantic. A more detailed map of the drought regions is shown in **Figure 66** below.

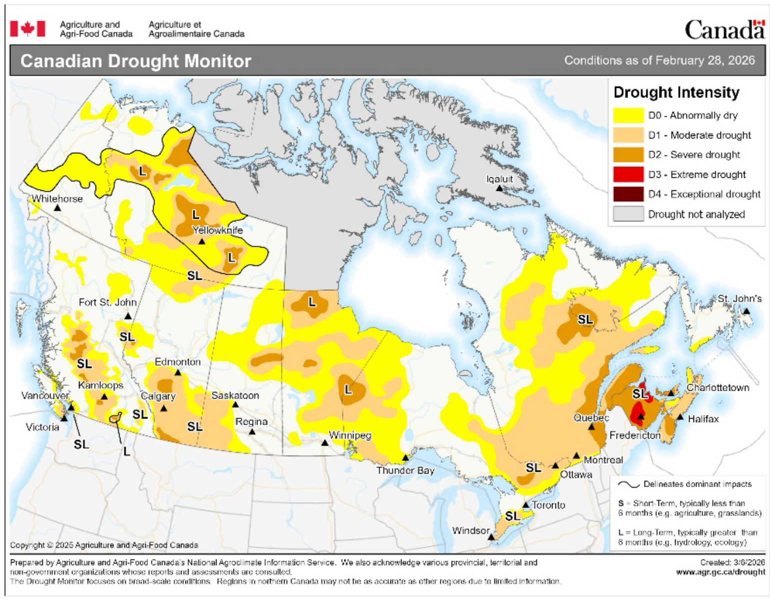

Figure 66. Drought conditions as of March 6, 2026. Source: Agriculture and Agri-Food Canada.

Many of the drought designations in Figure 66 are "SL", which means that the drought across Canada is expected to be a mix of short-term (6 months or less) and long-term (more than 6 months).

It remains to be seen how much of the Canadian drought will persist during summer 2026. However, the severity of the current drought, combined with model predictions of above-normal temperatures and below-normal precipitation over the worst drought regions of southeastern Canada during the summer of 2026, there is a good chance that above average smoke production will continue. In addition, if fire activity increases in those regions closer to the northeastern United States, the potential for smoke impacts to ozone and $PM_{2.5}$ in the Mid-Atlantic could also increase during summer 2026.

5.7 Implications for Summer 2026 Ozone and $PM_{2.5}$ in Delaware

Long-range air quality forecasting is inherently challenging due to the complexity of the interactions among the atmosphere, oceans, ice, and land. In addition, there are no linear relationships between certain climate regimes and air quality impacts. However, considering the outlooks and products discussed so far in Section 5, some general observations can be made to help inform a long-range air quality outlook.

Summarizing the methods discussed throughout Section 5, above-average precipitation is favored this summer in Delaware. The first indication that precipitation will be above average relates to the ENSO forecast. Model forecasts in NOAA's ENSO outlook favor a transition to ENSO-neutral conditions in the equatorial Pacific during spring 2026. On average over the last few decades, ENSO-similar summers in the Pacific resulted in above-average precipitation in the Mid-Atlantic. In addition to the evidence from the ENSO forecast, the forecast from the CanSIPS model is for above-average precipitation in Delaware this summer. Furthermore, long-term precipitation trends indicate summers are trending wetter across the northeastern United States. Finally, CPC's forecast for the summer indicates a 40–50% chance for above-average precipitation in Delaware this summer. Due to the agreement amongst these various methods and products, Spheros meteorologists are forecasting a good chance of above-average precipitation for summer 2026 in Delaware.

In terms of temperatures, the CanSIPS model is forecasting above-average temperatures in the mid-Atlantic this summer. In addition, temperature trends are also toward gradually increasing warmth from the Mid-Atlantic into the northeastern United States during the summer. Furthermore, CPC's forecast for the summer indicates a 40–50% chance of above-normal temperatures. While ENSO-similar summers have resulted in near-to-below-average temperatures in the region, with all other methods indicating the potential for increased temperatures along the East Coast, meteorologists at Spheros are forecasting above-average temperatures in the Mid-Atlantic again this summer.

While the forecast for above-average temperatures could result in increased ozone formation in Delaware this summer, the effects of the warm temperatures could be mitigated by increased precipitation, which may result in decreased solar input and ozone development. However, with potential long-term drought impacts across southeastern Canada and periods of northwesterly mid-level winds expected behind occasional cold fronts this summer, increased smoke impacts are possible in the Mid-Atlantic. The potential periodic increase in smoke could result in increased concentrations of $PM_{2.5}$ and ozone precursors in the region. Taking into consideration the potential for above-average temperatures and rainfall, combined with increased potential for smoke transport into the Mid-Atlantic, ozone AQI levels are forecast to be near-to-above average, while $PM_{2.5}$ AQI levels are forecast to be above average across Delaware during summer 2026.