PM2.5 National Ambient Air Quality Standard Health Exceedances on July 20, 2021

Exceedance Locations and Levels

On Tuesday, July 20, 2021, there were eight (8) exceedances in New Jersey of the National Ambient Air Quality Standard (NAAQS) for PM2.5 (24-hour average of 35 micrograms/cubic meter, ug/m3). Note, a PM2.5 exceedance of the 24-hour NAAQS is measured when the concentration is 35.5 ug/m3 or greater. Two stations, Jersey City Firehouse and Flemington, measured 24-hour averages above the NAAQS, but did not have enough valid hours to meet EPA criteria for a valid 24-hour average. (All of NJ is in attainment for the PM2.5 annual and 24-hour NAAQS and there are no downwind nonattainment areas from NJ.) See Table 1.

Table 1. New Jersey PM2.5 Concentrations on 7/20/2021

STATION	24-Hour Average (ug/m3)
Brigantine	28.1
Camden Spruce St	43.3
Columbia WMA	41.1
Elizabeth Lab	No Data
Flemington	68.6*
Fort Lee Near Road	49.9
Jersey City Firehouse	58.5*
Millville	26.6
Newark Firehouse	45.1
Rahway	46.1
Rider University	No Data
Rutgers University	45.7
Toms River	40.0
Trenton	46.0
TOTAL EXCEEDANCES	8

*Concentration does not meet EPA's criteria for a valid 24-hour average.

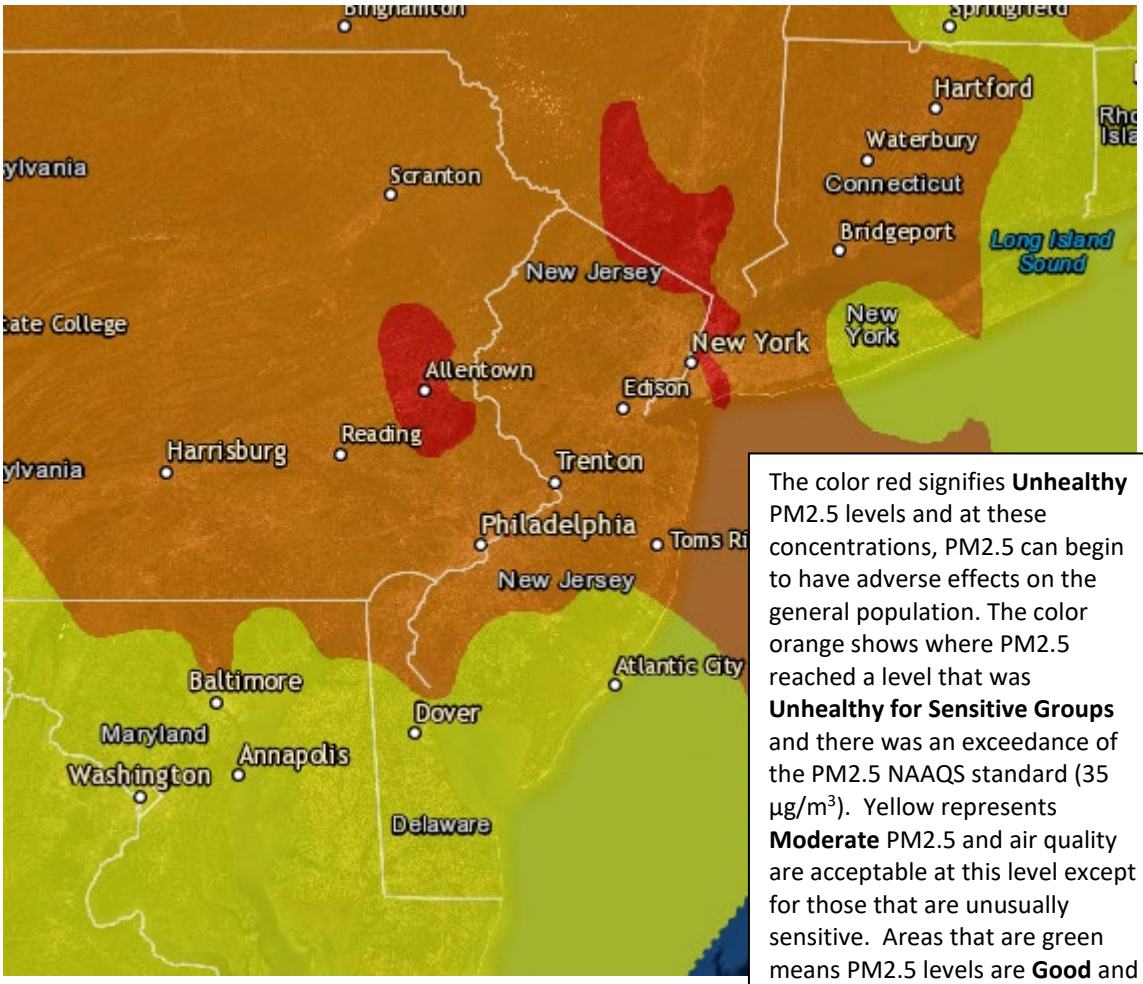
From the out-of-state stations adjacent to New Jersey, there were twenty-six (26) exceedances of the PM2.5 NAAQS. See Table 2.

Table 2. PM2.5 Concentrations at Out-of-State Monitoring Stations Adjacent to New Jersey on 7/20/2021

STATE	STATION	24-Hour Average (ug/m3)
CT	Bridgeport	40.8
CT	Danbury	49.5
CT	New Haven - Criscuolo Park	37.7
CT	Waterbury	52.6
DE	KILLENS (Kent Co.)	30.0
DE	LUMS 2 (New Castle Co.)	42.6
DE	MLK (New Castle Co.)	52.8
DE	Rte 9 Del City	43.7
DE	SEAFORD (Sussex Co.)	27.2
MD	Fair Hill	42.4
NY	Bklyn - PS274	59.9
NY	CCNY	56.4
NY	Division Street	No Data
NY	Eisenhower Park	42.4
NY	Fresh Kills	55.0
NY	Holtsville	31.9
NY	Manhattan/IS143	61.5
NY	Maspeth	53.7
NY	Queens Near-road	53.9
NY	Queens	No Data
NY	White Plains	51.4
PA	Allentown	60.2
PA	Chester	52.0
PA	Freemansburg	54.7
PA	Marcus Hook	51.3
PA	New Garden	50.5
PA	Norristown	55.4
PA	FAB (Philadelphia Co.)	No Data
PA	MON (Philadelphia Co.)	51.1
PA	NEW (Philadelphia Co.)	57.8
PA	RIT (Philadelphia Co.)	49.5
PA	TOR (Philadelphia Co.)	52.7
	TOTAL EXCEEDANCES	26

Figure 1 shows the widespread nature of this event with unhealthy for sensitive groups PM2.5 levels noted in orange throughout the region and moderated levels noted in yellow. Locally, the highest PM2.5 levels were observed over the Lower Hudson Valley in New York and Allentown, Pennsylvania reaching the unhealthy category (noted in red).

Figure 1. PM2.5 Air Quality Index for July 20, 2021



The color red signifies **Unhealthy** PM2.5 levels and at these concentrations, PM2.5 can begin to have adverse effects on the general population. The color orange shows where PM2.5 reached a level that was **Unhealthy for Sensitive Groups** and there was an exceedance of the PM2.5 NAAQS standard (35 $\mu g/m^3$). Yellow represents **Moderate** PM2.5 and air quality are acceptable at this level except for those that are unusually sensitive. Areas that are green means PM2.5 levels are **Good** and pose little risk.

Source: www.airnow.gov

For PM2.5 terminology definitions see NJDEP Air Quality Planning's Glossary and Acronyms webpage: http://nj.gov/dep/baqp/glossary.html

Weather

A complex atmospheric setup on Tuesday, July 20, 2021, allowed for the synoptic transport of wildfire smoke over the northeastern United States. This wildfire smoke, originating from the western United States and Canada, was ushered into the region throughout the day and led to widespread PM2.5 exceedances across the nonattainment area.

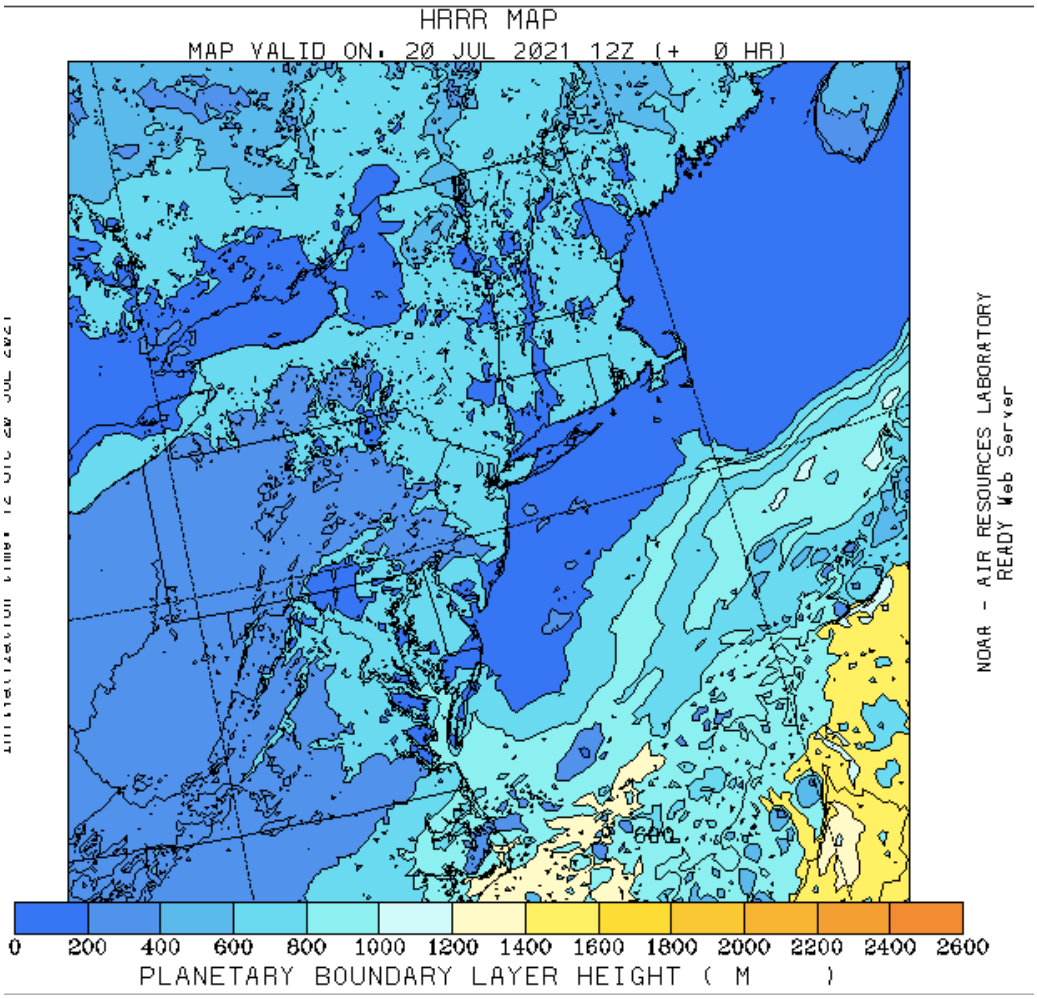
High pressure centered over the Appalachian Valley remained anchored throughout the day. The location of this high-pressure center allowed for light winds at the surface, varying west to northwest, as well as limited atmospheric ventilation. Meanwhile, in the mid and upper levels of the atmosphere, winds were steady from the northwest allowing for the quick transport of wildfire smoke into the region. Under the influence of a sinking motion associated with high pressure, this smoke was brought down to the surface, allowing for the rapid rise of PM2.5 levels across the Northeast. Additionally, a surface trough developed over the Mid-Atlantic region during the mid-day hours allowing smoke aloft to further mix down to the surface. Overall, PM2.5 levels associated with wildfire smoke remained high throughout the day which resulted in widespread PM2.5 exceedances throughout the nonattainment area. The impact of the wildfire smoke was easily observed from outdoors by the hazy appearance of the sky which obstructed the visibility of the clouds and sun.

Where Did the Air Pollution that Caused an Exceedance in PM2.5 Come From?

A favorable atmospheric setup with high pressure anchored over the Appalachian Valley, as well as a developing surface trough throughout the afternoon allowed for a regional increase of fine particulate (PM2.5) levels associated with wildfire smoke from the western United States and Canada on July 20th. Although emissions from cars, trucks, and industry contribute to PM2.5 air quality, the elevated levels of PM2.5 are due to the wildfire smoke from upwind regions. Additionally, limited mixing heights allowed the combination of the pollution from these sources to accumulate close to the surface, leading to a regional NAAQS PM2.5 exceedance event throughout the Northeast.

High PM2.5 events are typically associated with limited atmospheric mixing. The planetary boundary layer (PBL) can be considered the lowest point of the troposphere where atmospheric mixing occurs and is known to change along with the weather pattern. Under the atmospheric setup on July 20th, relatively low mixing heights were observed, trapping PM2.5 associated with the wildfire smoke from the western United States and Canada toward the surface, enhancing particulate concentrations. Figure 2 shows the PBL heights over the region early in the day on July 20th. As shown, significantly low mixing heights above ground level (AGL) were observed throughout the nonattainment zone and entire northeastern United States on this day.

Figure 2. Regional Planetary Boundary Layer Height on July 20th, 2021 (mAGL)



Figures 3, 4, and 5 show surface level back trajectories for the monitored exceedances on July 20, 2021. The figures illustrate where surface winds came from during the 48 hours preceding the high PM2.5 event. With the low mixing heights and limited vertical mixing on this day, surface, mid, and upper-level back trajectories will help provide the best visual of PM2.5 transport. Ten (10) monitoring stations in the region with 24-hr PM2.5 NAAQS exceedances were used to run back trajectories. The selected sites and the 24-hr average PM2.5 level recorded are listed in Table 3 below:

Table 3. Monitoring Stations in New Jersey and Adjacent States with a 24-hr PM2.5 NAAQS Exceedance that were Selected to Run 48-hr Back Trajectories

STATE	STATION	24-Hour Average ($\mu g/m^3$)
CT	Danbury	49.5
CT	New Haven - Criscuolo Park	37.7
NY	CCNY	56.4
NY	Fresh Kills	55.0
NY	White Plains	51.4
PA	Chester	52.0
PA	Allentown	60.2
PA	NEW	57.8
PA	NORR	55.4
DE	MLK	52.8

Backward trajectories from Tuesday, July 20th show that high pressure, light winds, and limited atmospheric ventilation were in place while a plume of smoke migrated over the nonattainment area. The favorable weather conditions mentioned above, allowed this plume to mix down to the surface resulting in rising concentrations at the ground level. The trajectory transport paired with wildfire smoke from the western United States and Canada created a favorable environment for a widespread PM2.5 event to occur.

Low level (10 m) back trajectories (Figure 3) show that 48 hours prior to the exceedance event, air at the surface originated over southern Ontario and Quebec. This air mass traveled in a general southeast direction across southern Ontario and the city of Toronto before entering upstate New York. At this time, air at the surface was already heavily concentrated with a previously existing smoke plume from the wildfires occurring in the western United States and Canada. Along the trajectory path, a blanket of elevated PM 2.5 levels was observed in the unhealthy for sensitive groups (USG) and unhealthy category as the smoke plume migrated southward. As a result, the smoke plume quickly deteriorated air quality for all locations along its path. From here, trajectories followed the same southeasterly direction however, while many traveled over northeastern Pennsylvania, others traveled over much of New York State. During the final hours of transit, trajectories slowed to a crawl as they encountered the heavy sinking motion of high pressure and a surface trough. The combination of these features allowed the wildfire smoke at higher altitudes to mix down to the surface very rapidly resulting in an abrupt spike in concentrations by mid-morning. Also, air traveling at ground level during this event likely picked up emissions from cars, trucks, and industrial facilities.

Mid-level (500 m) and upper-level (1500 m) back trajectories (Figures 4 & 5) show that air originated mainly along the Ontario/Quebec border in southern Canada, with an isolated trajectory originating in the Great Lakes region. As detected from satellite imagery, the air mass aloft over this region on July 18th and 19th was heavily polluted with wildfire smoke from fires burning throughout the western United States and Canada. Northwesterly upper-level winds helped to transport this smoke aloft in a southeasterly direction over southern Ontario and Quebec, New York State, and Pennsylvania, gathering additional fine particulate pollution from cars, trucks, and industry along the way. Air at both mid- and upper-levels experienced a gradual sinking motion towards the surface under the influence of high

pressure, allowing any wildfire smoke aloft to mix down and enhance surface-level PM2.5 concentrations throughout the Northeast.

Figure 6 shows national PM2.5 concentrations observed on July 19, 2021, the day prior to this high PM2.5 event. As shown in the figure, widespread moderate, portions of USG, and isolated Unhealthy air quality were observed throughout the Great Lakes region, the Ohio River Valley, and Mid-Atlantic region. This widespread plume of elevated PM2.5 concentrations extended throughout much of the northern Unites States into portions of Idaho, Oregon, Washington, Nevada, and California, where most of the wildfire smoke originated. The location of the previously polluted air mass in combination with the favorable meteorological conditions and transport patterns mentioned above, allowed for enhanced levels of PM2.5 leading to a widespread regional exceedance event.

Figure 3. 48-hour Back Trajectories for July 21, 2021 at 10 meters

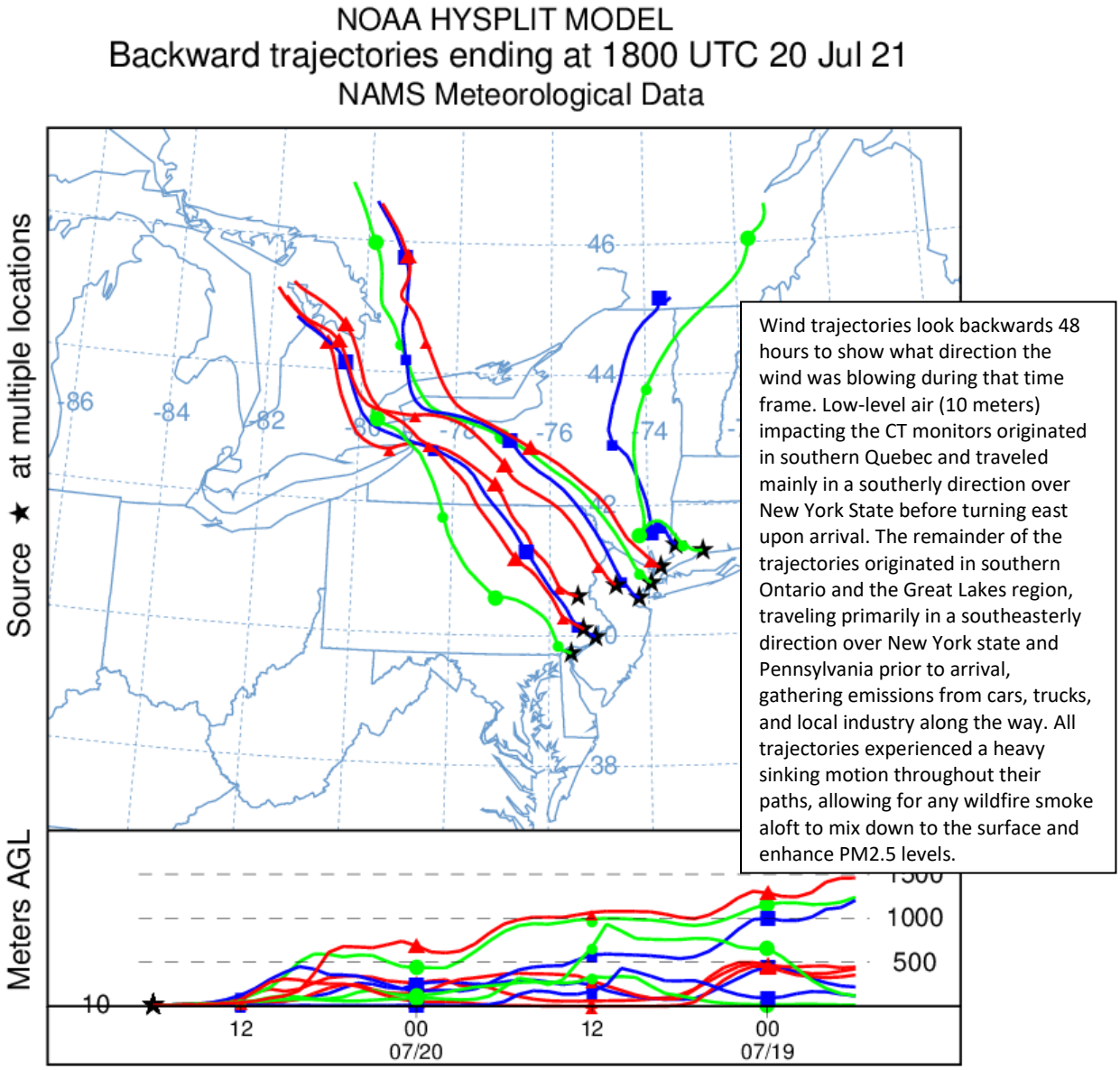


Figure 4. 48-hour Back Trajectories for July 21, 2021 at 500 meters

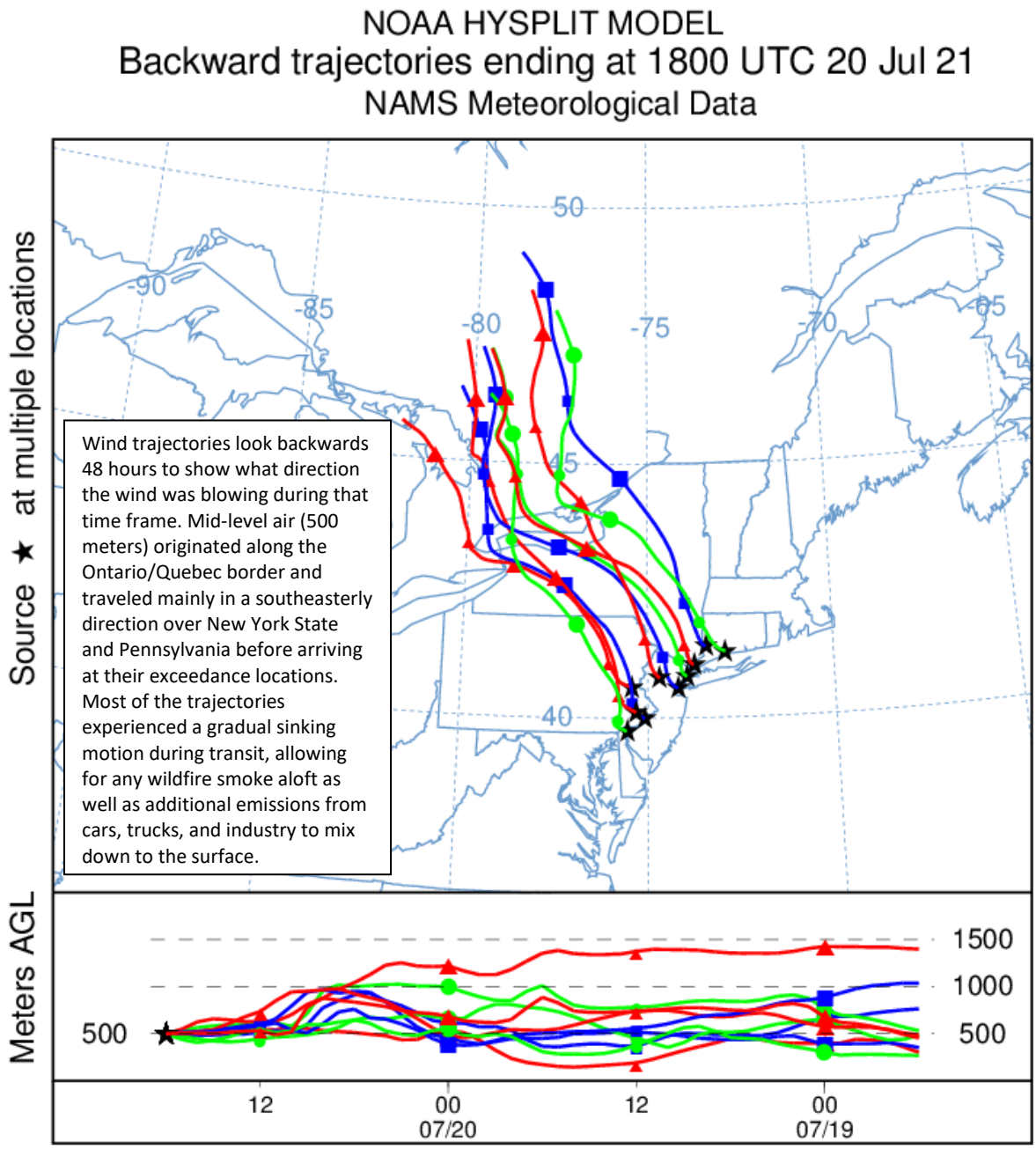


Figure 5. 48-hour Back Trajectories for July 21, 2021 at 1500 meters

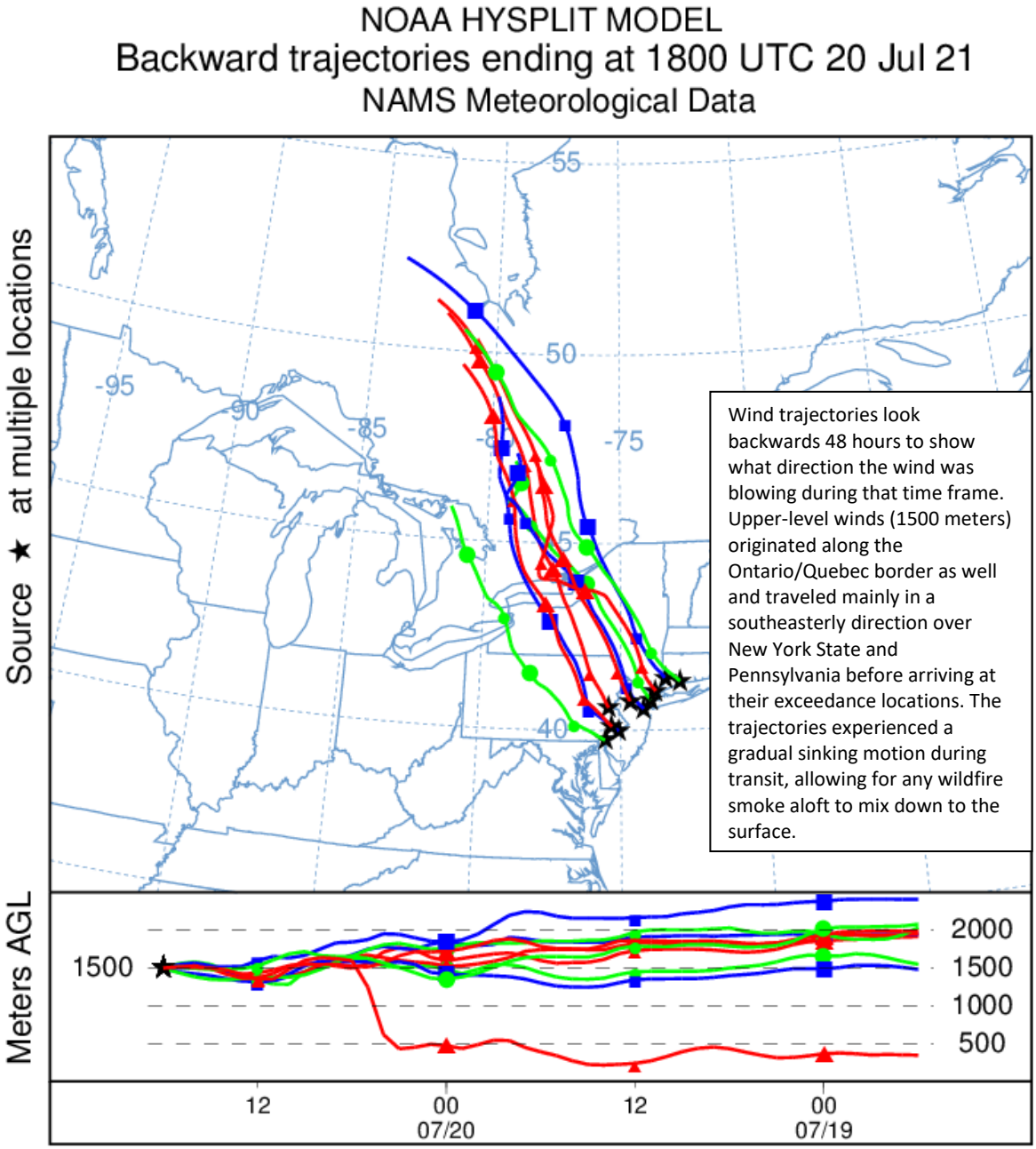
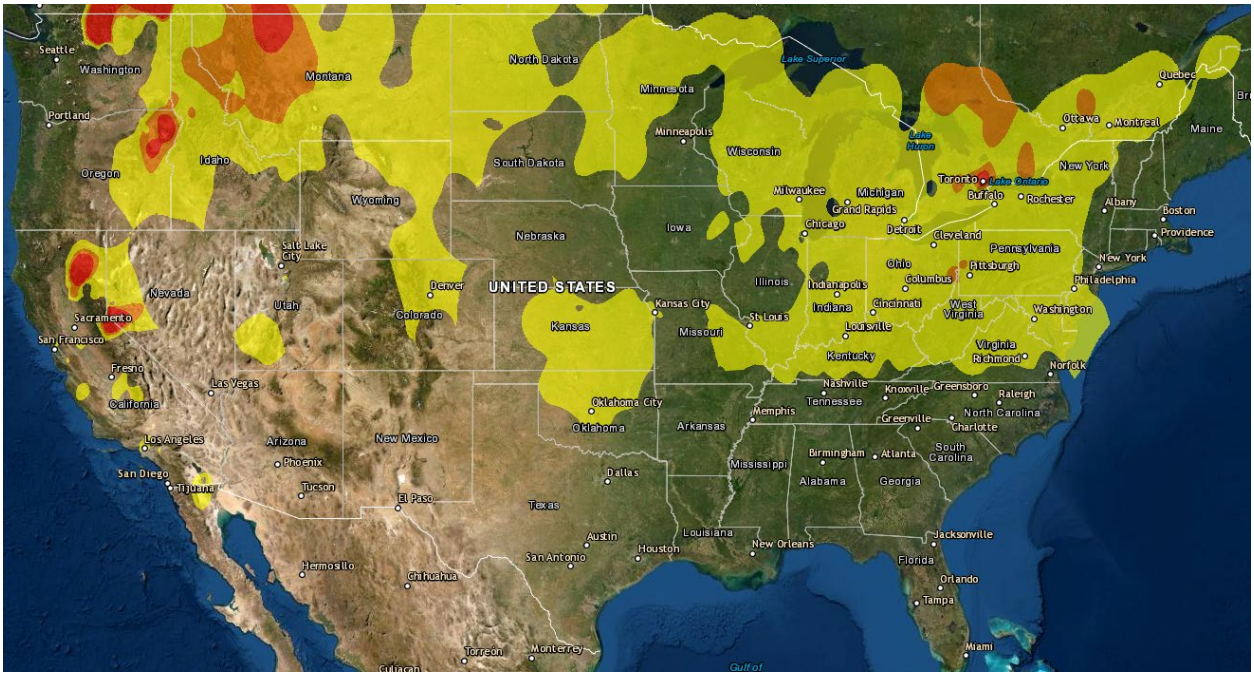


Figure 6. National PM2.5 Air Quality Index for July 19, 2021



Find Out About Air Quality Every Day

The “What's Your Air Quality Today?” page at http://www.nj.gov/dep/cleanairnj/ tells you how to sign up to receive notifications and find out when your local air has reached unhealthy ozone levels.