PM2.5 National Ambient Air Quality Standard Health Exceedances on July 21, 2021

Exceedance Locations and Levels

On Wednesday, July 21, 2021, there were three (3) exceedances in New Jersey of the National Ambient Air Quality Standard (NAAQS) for PM2.5 (24-hour average of 35 micrograms/cubic meter, ug/m^3). A PM2.5 exceedance of the 24-hour NAAQS is measured when the concentration is 35.5 ug/m^3 or greater. See Table 1.

Note, all of NJ is in attainment for the PM2.5 annual and 24-hour NAAQS and there are no downwind nonattainment areas from NJ.

Table 1. New Jersey PM2.5 Concentrations on 7/21/2021

STATION	24-Hour Average (ug/m^3)
Brigantine	27.0
Camden Spruce St	36.3
Columbia WMA	24.9
Elizabeth Lab	No Data
Flemington	33.6
Fort Lee Near Road	27.4
Jersey City Firehouse	27.5
Millville	29.1
Newark Firehouse	33.3
Rahway	27.3
Rider University	No Data
Rutgers University	40.2
Toms River	35.9
Trenton	28.6
TOTAL EXCEEDANCES	3

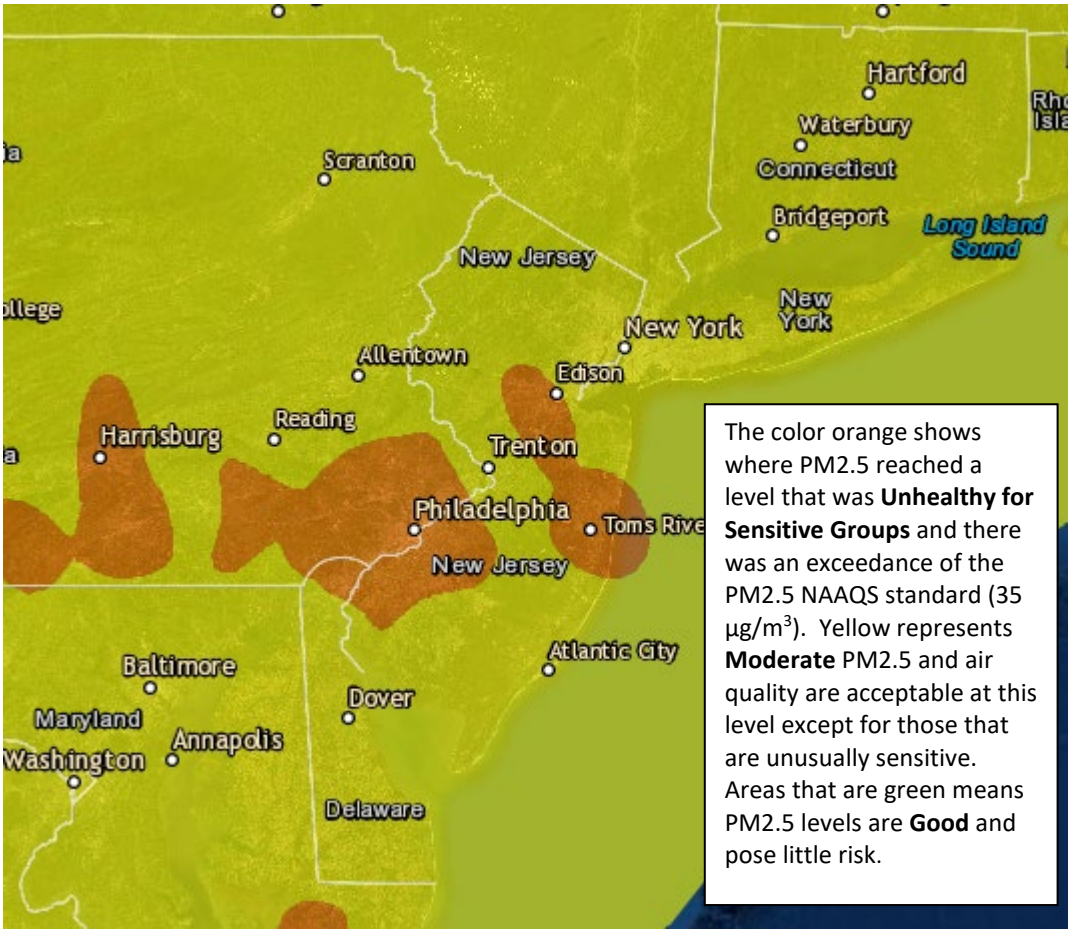
From the out-of-state stations adjacent to New Jersey, there were nine (9) exceedances of the PM2.5 NAAQS. See Table 2.

Table 2. PM2.5 Concentrations at Out-of-State Monitoring Stations Adjacent to New Jersey on 7/21/2021

STATE	STATION	24-Hour Average (ug/m^3)
CT	Bridgeport	28.8
CT	Danbury	17.1
CT	New Haven - Criscuolo Park	23.6
CT	Waterbury	20.7
DE	KILLENS (Kent Co.)	31.7
DE	LUMS 2 (New Castle Co.)	32.9
DE	MLK (New Castle Co.)	37.5
DE	Rte 9 Del City	31.7
DE	SEAFORD (Sussex Co.)	32.8
MD	Fair Hill	30.1
NY	Bklyn - PS274	32.7
NY	CCNY	23.5
NY	Division Street	No Data
NY	Eisenhower Park	30.3
NY	Fresh Kills	33.3
NY	Holtsville	27.4
NY	Manhattan/IS143	23.4
NY	Maspeth	21.9
NY	Queens Near-road	28.5
NY	Queens	No Data
NY	White Plains	20.6
PA	Allentown	29.5
PA	Chester	39.5
PA	Freemansburg	27.1
PA	Marcus Hook	38.5
PA	New Garden	36.1
PA	Norristown	38.2
PA	FAB (Philadelphia Co.)	No Data
PA	MON (Philadelphia Co.)	36.9
PA	NEW (Philadelphia Co.)	41.7
PA	RIT (Philadelphia Co.)	37.7
PA	TOR (Philadelphia Co.)	38.5
	TOTAL EXCEEDANCES	9

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 central New Jersey and the greater Philadelphia area where unhealthy for sensitive groups PM2.5 levels were recorded.

Figure 1. PM2.5 Air Quality Index for July 21, 2021



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

Weakening high pressure and an approaching cold front on Wednesday, July 21, 2021, allowed for the wildfire smoke, originating from the western United States and Canada, to slowly exit the northeastern United States throughout the day. As a result, a gradual reduction of PM2.5 levels was observed from north to south as the cold front progressed. Locations in central / southern New Jersey as well as surrounding Mid-Atlantic states such as Pennsylvania and Delaware were the last to see an influence from the front and therefore, recorded the highest regional levels of PM2.5 on this day, leading to several exceedances in these locations.

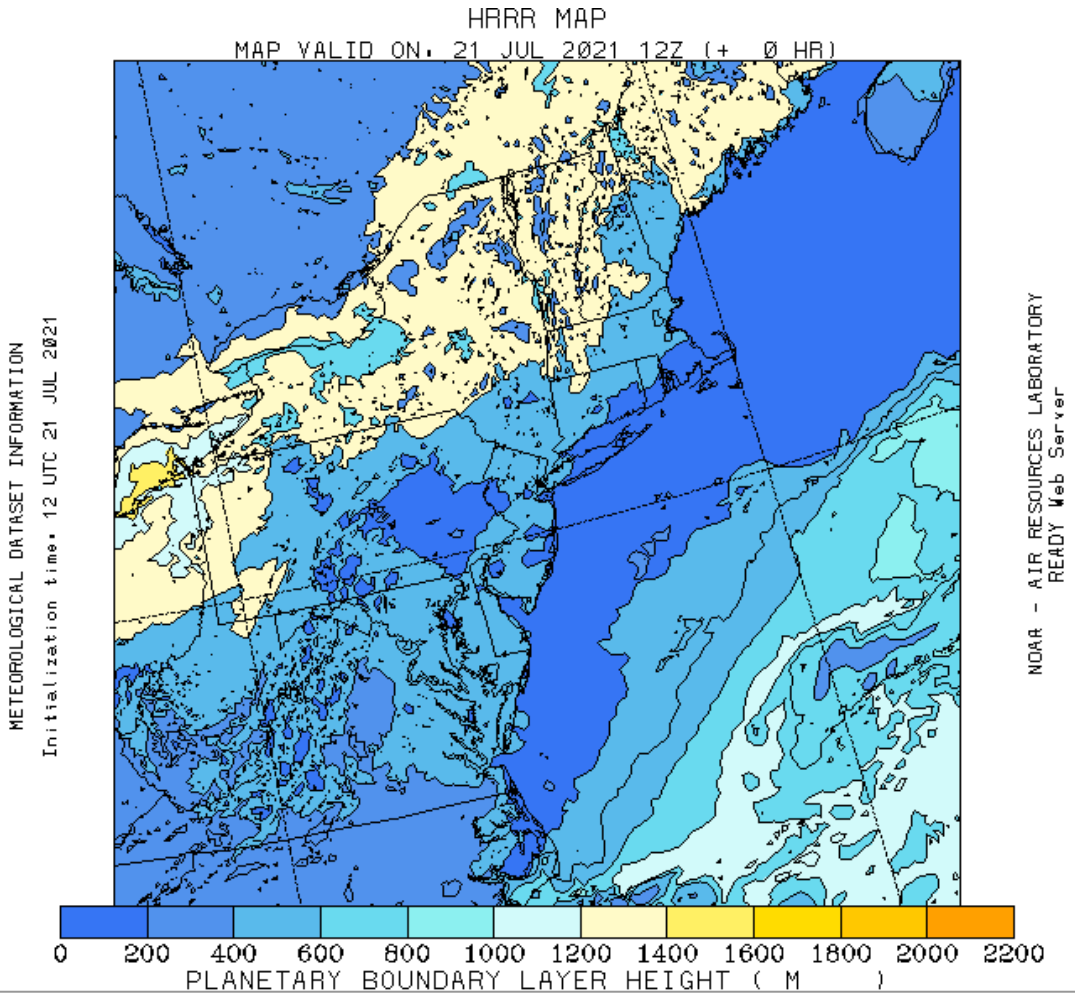
High pressure over the Mid-Atlantic region, which dominated the weather pattern several days prior, gradually weakened throughout the day on Wednesday. In the early morning hours, limited atmospheric ventilation was noted with light and variable winds observed across New Jersey. These conditions allowed for wildfire smoke, still influencing the region, to accumulate at the surface, keeping PM2.5 levels regionally high. Additionally, in the mid-upper levels of the atmosphere, a northwest and westerly transport was noted, allowing for a more synoptic transport of wildfire smoke across Pennsylvania into New Jersey, furthering enhancing morning PM2.5 levels. By mid-day, a cold front passed over New Jersey from northwest to southeast, allowing for widespread showers and thunderstorms and providing a much-needed relief to the hazy atmospheric conditions. In the wake of this front, the smoke laden airmass gradually cleared in the evening and overnight hours, lowering PM2.5 levels state-wide.

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

A favorable atmospheric setup with high pressure centered overhead, as well as a persistent surface trough over the region allowed for continued elevated fine particulate (PM2.5) levels associated with wildfire smoke from the western United States and Canada on July 21st. Although emissions from cars, trucks, and industry contribute to PM2.5 air quality, the elevated levels of PM2.5 were 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 several NAAQS PM2.5 exceedances throughout the Philadelphia metropolitan area and central New Jersey.

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 21st, relatively low mixing heights were observed, trapping the PM2.5 associated with the wildfire smoke from the western United States and Canada near the surface. Figure 2 shows the PBL heights over the region early in the day on July 21st. 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 21st, 2021 (mAGL)



Figures 3, 4, and 5 show surface level back trajectories for the monitored exceedances on July 21, 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. Six (6) 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 ($\mu g/m^3$)
NJ	Camden Spruce St.	36.3
NJ	Rutgers University	40.2
NJ	Toms River	35.9
PA	Chester	39.5
PA	NORR	38.2
PA	TOR	38.5

Backward trajectories from Wednesday, July 21st show that overhead high pressure, light winds, and limited atmospheric ventilation remained in place, while a plume of wildfire smoke from the western United States and Canada continued to funnel into the nonattainment area. The favorable weather conditions mentioned above paired with a persistent transport pattern allowed this plume to mix down to an already polluted surface, allowing for multiple PM2.5 exceedances throughout the Philadelphia metropolitan area and central New Jersey.

Low level (10 m) back trajectories (Figure 3) show that 48 hours prior to the exceedance event, inland trajectories saw air that originated in the Great Lakes region and western New York. This air mass traveled in a general southeast direction over western New York before entering northern Pennsylvania. At this point in the trajectory, high pressure previously centered near West Virginia began to push northeastward over the trajectories, causing the air mass to drastically stall and meander in a clockwise direction around central/eastern Pennsylvania. At this time, air at the surface throughout Pennsylvania was already heavily concentrated with a previously existing smoke plume from the wildfires occurring in the western United States and Canada. Widespread unhealthy for sensitive groups (USG) and isolated unhealthy PM2.5 levels were noted throughout the state, resulting in an increasingly polluted air mass. As the trajectories made their final approach into eastern Pennsylvania and New Jersey, the air mass slowed to a crawl as they encountered the heavy sinking motion due to overhead high pressure and a surface trough. The isolated coastal trajectory that terminates at the Toms River monitor originated in the Chesapeake Bay region. This air mass remained at the surface through transit and traveled in a northeasterly direction over Delaware and southern New Jersey before arriving at the exceedance location, indicating that localized elevated PM2.5 levels contributed heavily to this exceedance. Air traveling at the surface in all trajectories likely picked up additional fine particulate emissions from cars, trucks, and local industry along the way.

Mid-level (500 m) and upper-level (1500 m) back trajectories (Figures 4 & 5) followed similar transport pathways and show that air originated mainly in southern Ontario, with an isolated trajectory originating in upstate New York. As detected from satellite imagery, the air mass aloft over this region on July 20th 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 Pennsylvania. Air at both mid- and upper-levels experienced a gradual sinking motion towards the surface during the entire 48-hr period due to the nature of the high-pressure system and the presence of a surface trough. Both features allowed 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 20, 2021, the day prior to this high PM2.5 event. As shown in the figure, widespread moderate air quality was observed upwind in the Great Lakes and Ohio Valley regions. In addition, widespread USG air quality was observed in the Mid-Atlantic with isolated areas of Unhealthy air quality within the nonattainment area. Not only did this extensive area of elevated PM2.5 concentrations blanket the nonattainment area, but it extended across much of the United States as well. The widespread nature of this plume in combination with favorable meteorological conditions and transport patterns mentioned above, allowed for a second day of high PM2.5 levels leading to a widespread regional event.

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

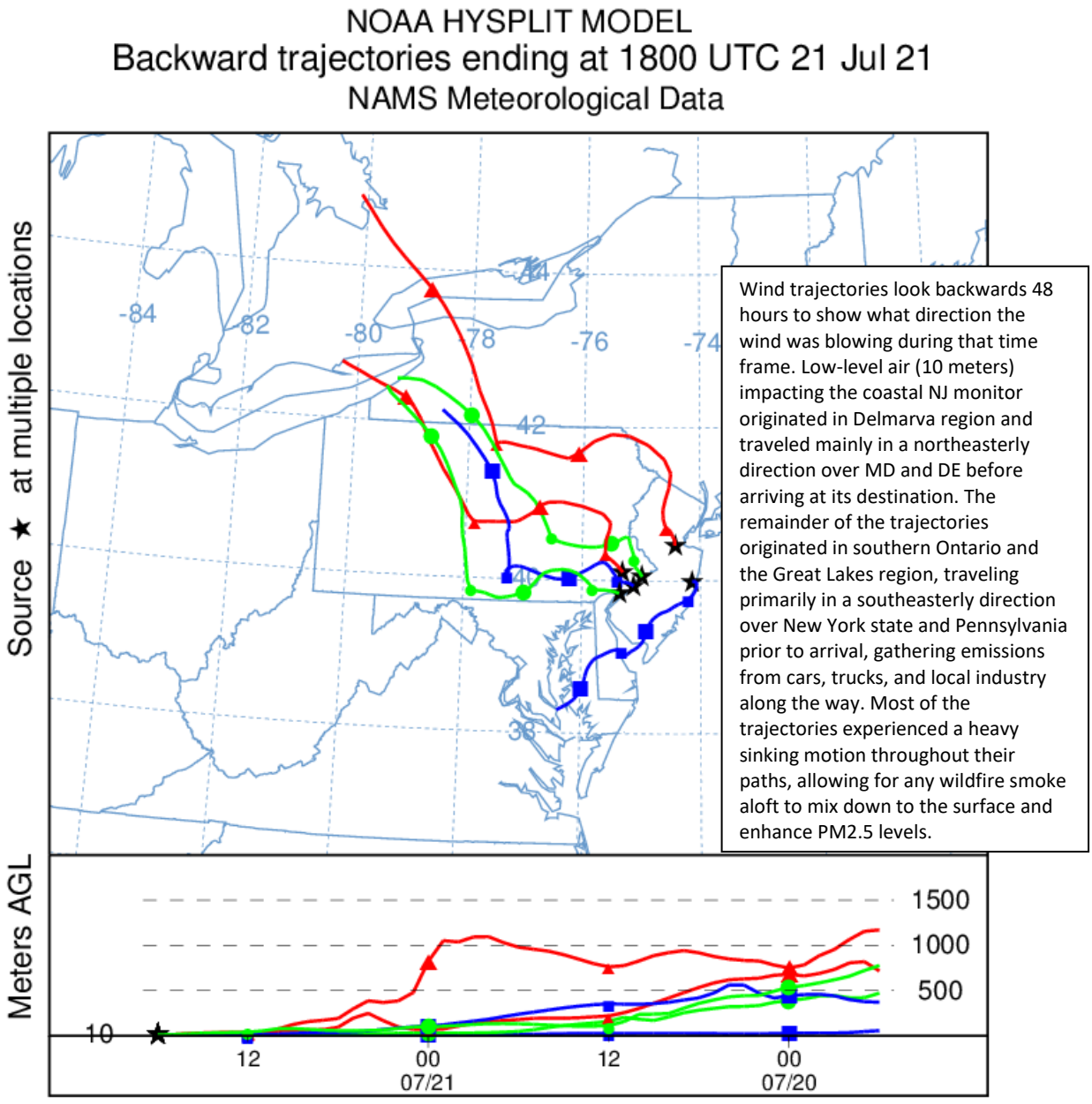


Figure 4. 48-hour Back Trajectories for July 21, 2021 at 500 meters

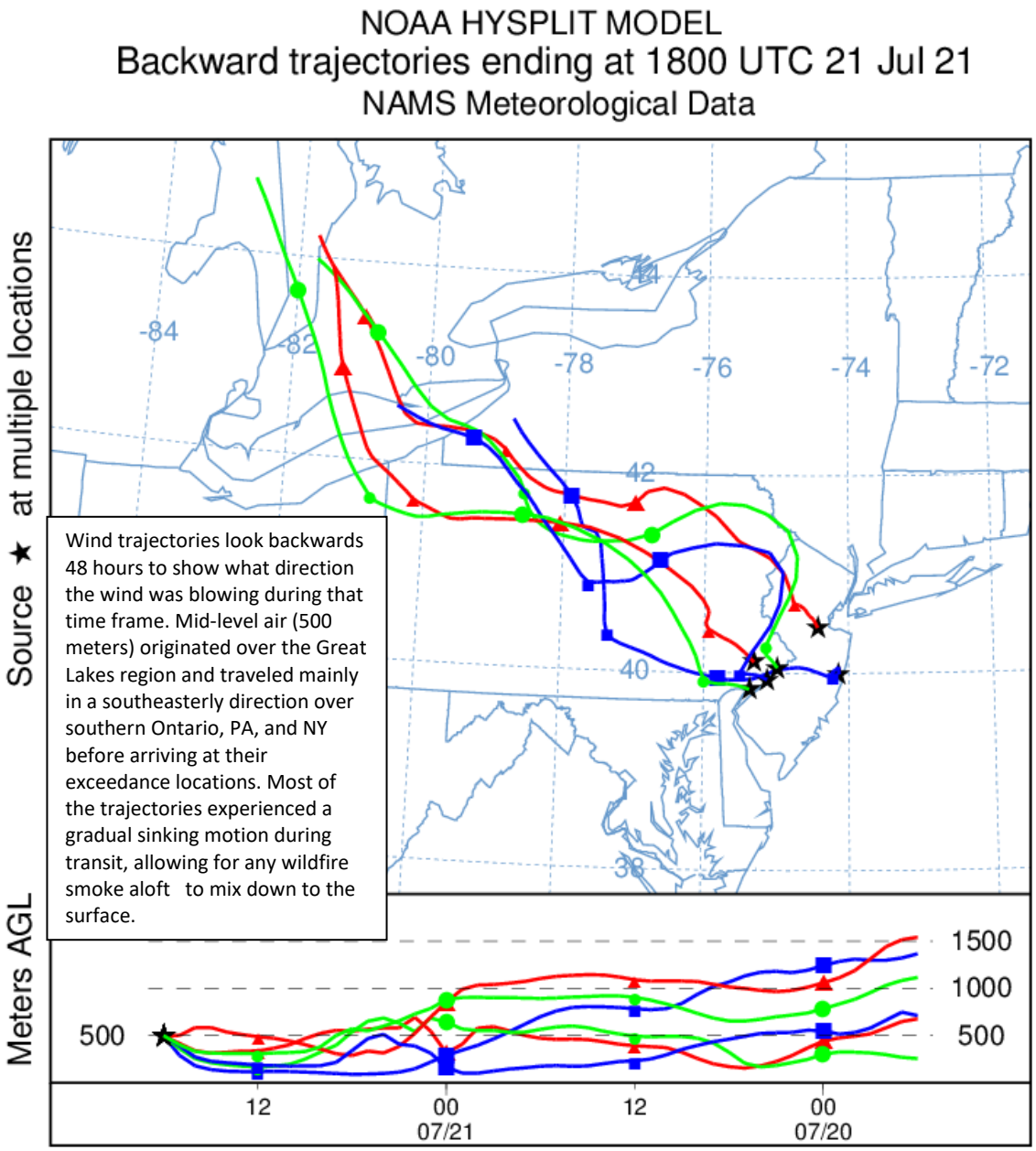


Figure 5. 48-hour Back Trajectories for July 21, 2021 at 1500 meters

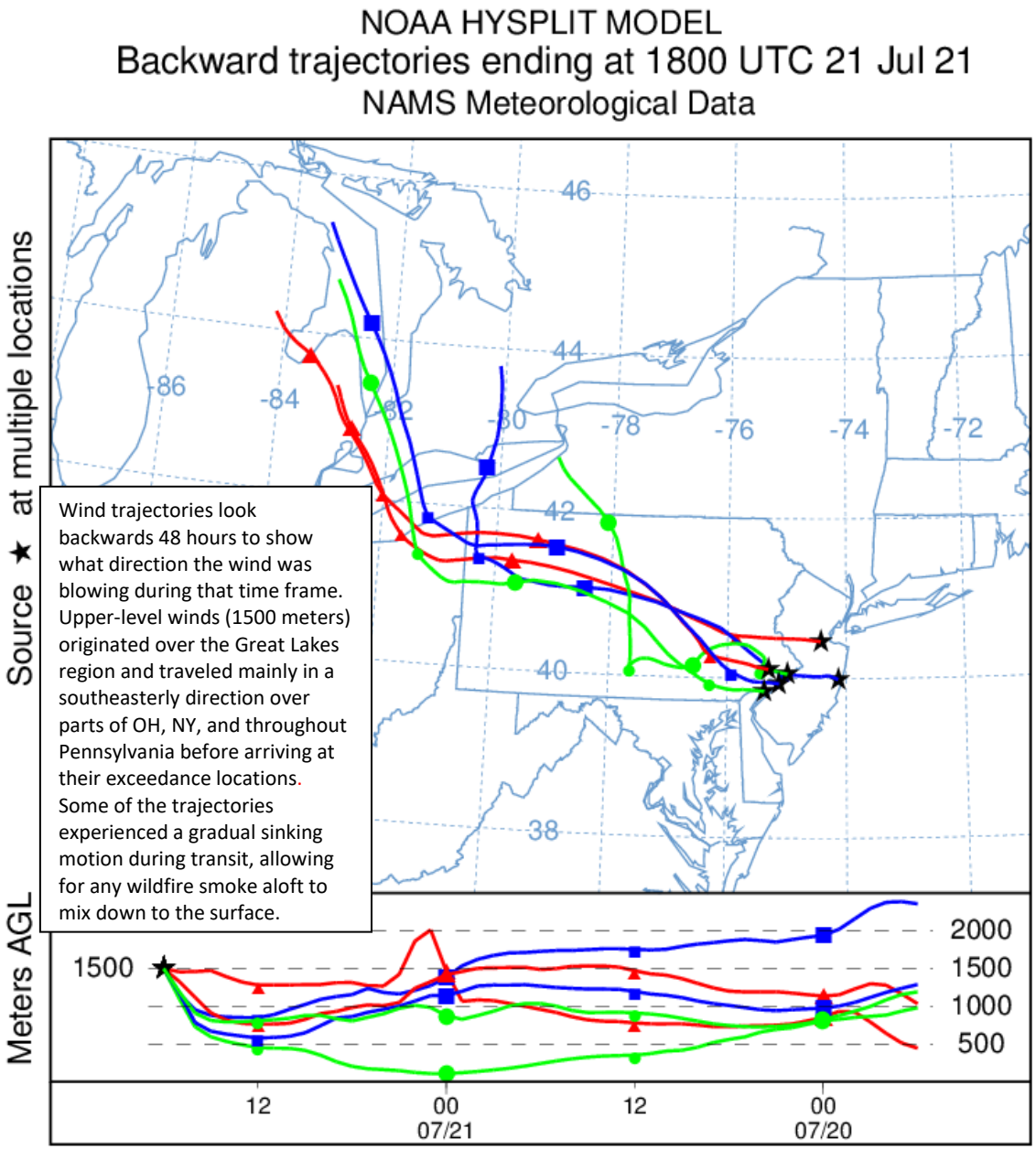
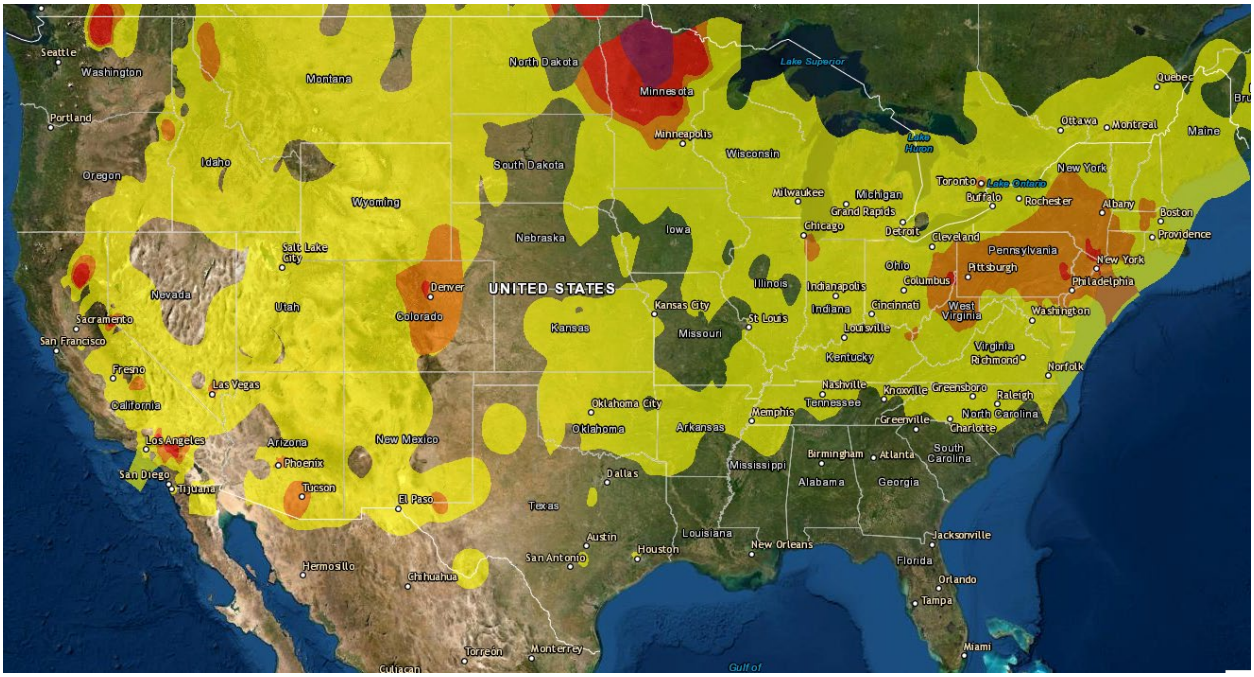


Figure 6. National PM2.5 Air Quality Index for July 20, 2021



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.