

Dust Report: 03 July 2020

What was the impact of the Godzilla dust event on PM10 in Florida in Late June 2020?

Joseph M. Prospero, Professor Emeritus, Department of Atmospheric Sciences & Rosenstiel School of Marine and Atmospheric Science, University of Miami

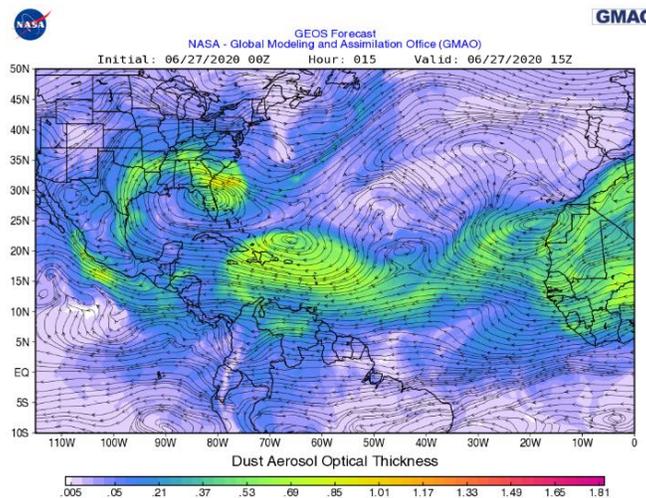
NOTE: These reports are informal ad-hoc quick studies that I assemble on the basis of my browsing which is sporadic and pursued with varying degrees of diligence. Feel free to comment as you deem appropriate.

The huge dust event that produced record dust concentrations at Barbados and on the Windward Islands on 21 – 22 June arrived in the Miami area about 25 June. In this report, I make a first attempt at assessing how this dust event impacted the PM10 air quality in the region.

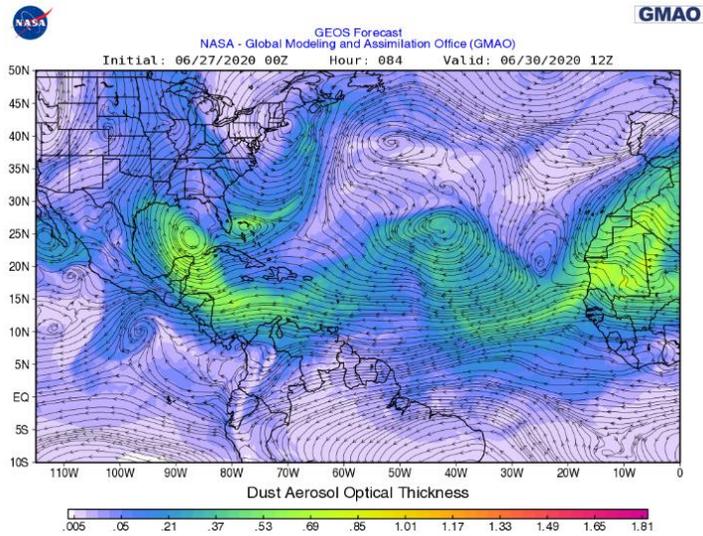
This is the dust distribution as seen in NASA Worldview on 27 June:



One can see the large hazy blob over northern Florida and Georgia and over the offshore waters (at the end of the black spike where the MODIS paths overlap). This is what the NASA GEOS-5 model shows for 27 June. Note that the southern border of this eastward-moving blob (the blue tones fringe areas) almost touches with the westward-moving blob located over the Windward Islands, Puerto Rico and Hispaniola. Over the course of the day, it will cover Cuba.

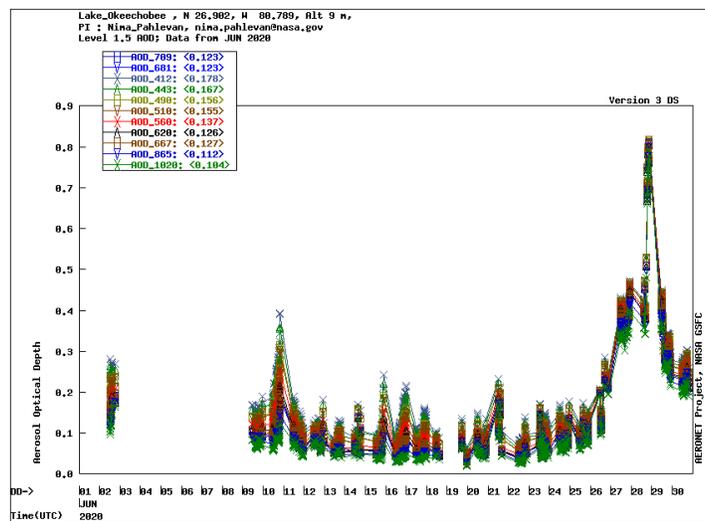


On the 30th of June, the dust cloud has mostly passed off the SE coast.

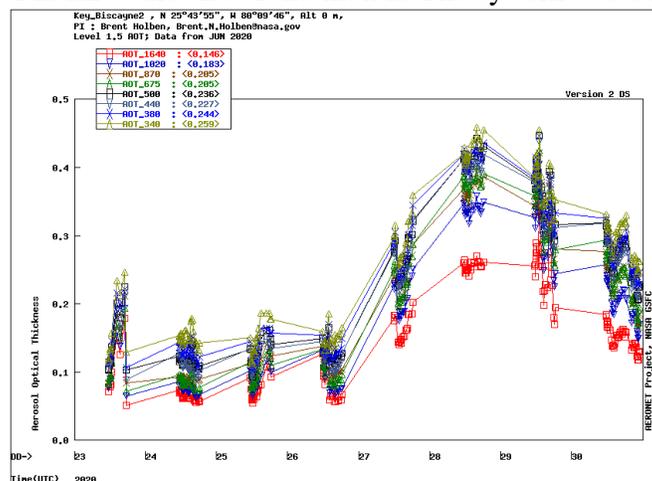


One can follow the passage of this dust cloud in the aerosol optical depth at an AERONET site on Lake Okeechobee about 120 km north of Miami. (The Miami site only came back online very late in the month.)

https://aeronet.gsfc.nasa.gov/cgi-bin/data_display_aod_v3?site=Lake_Okeechobee&nachal=0&year=2020&month=6&aero_water=0&level=2&if_day=0&if_err=0&place_code=10&year_or_month=0

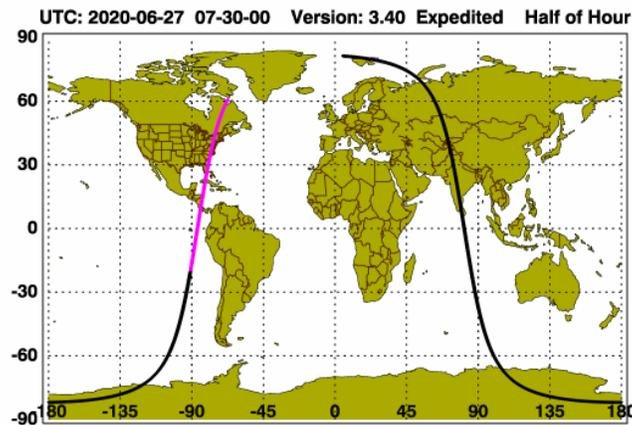


This is the AOD record at Miami at the end of the month. The system was down earlier in the month.

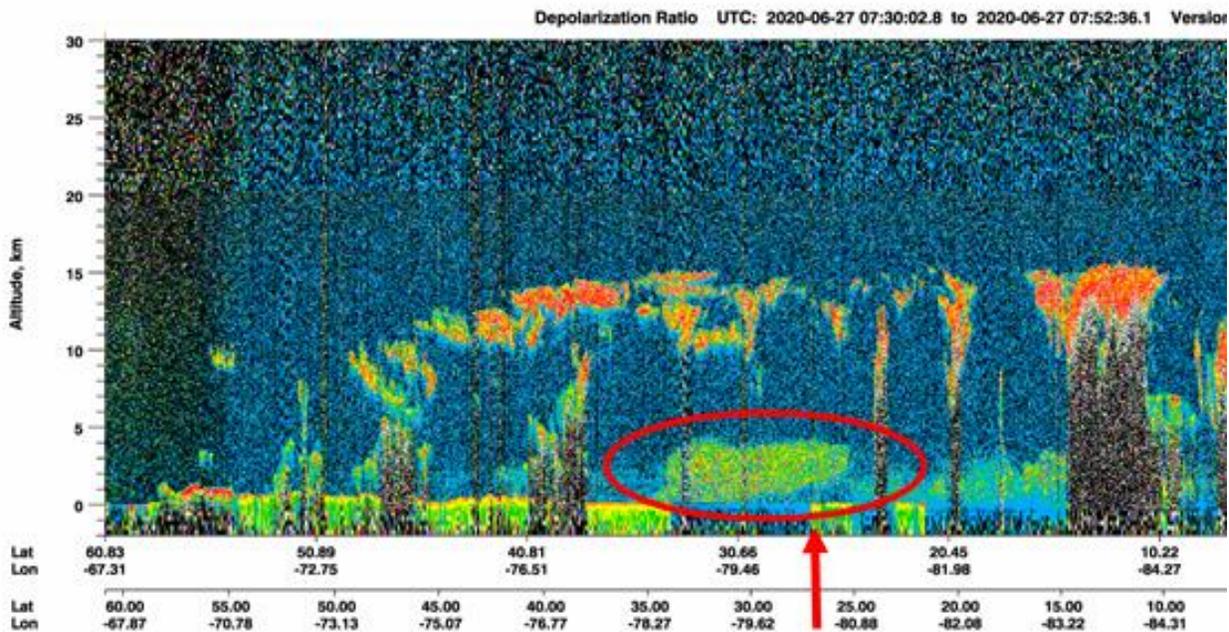


On 27 June, the CALIPSO lidar satellite passed directly over the length of Florida.

https://www-calipso.larc.nasa.gov/products/lidar/browse_images/exp_showdate.php?browse_date=2020-06-27

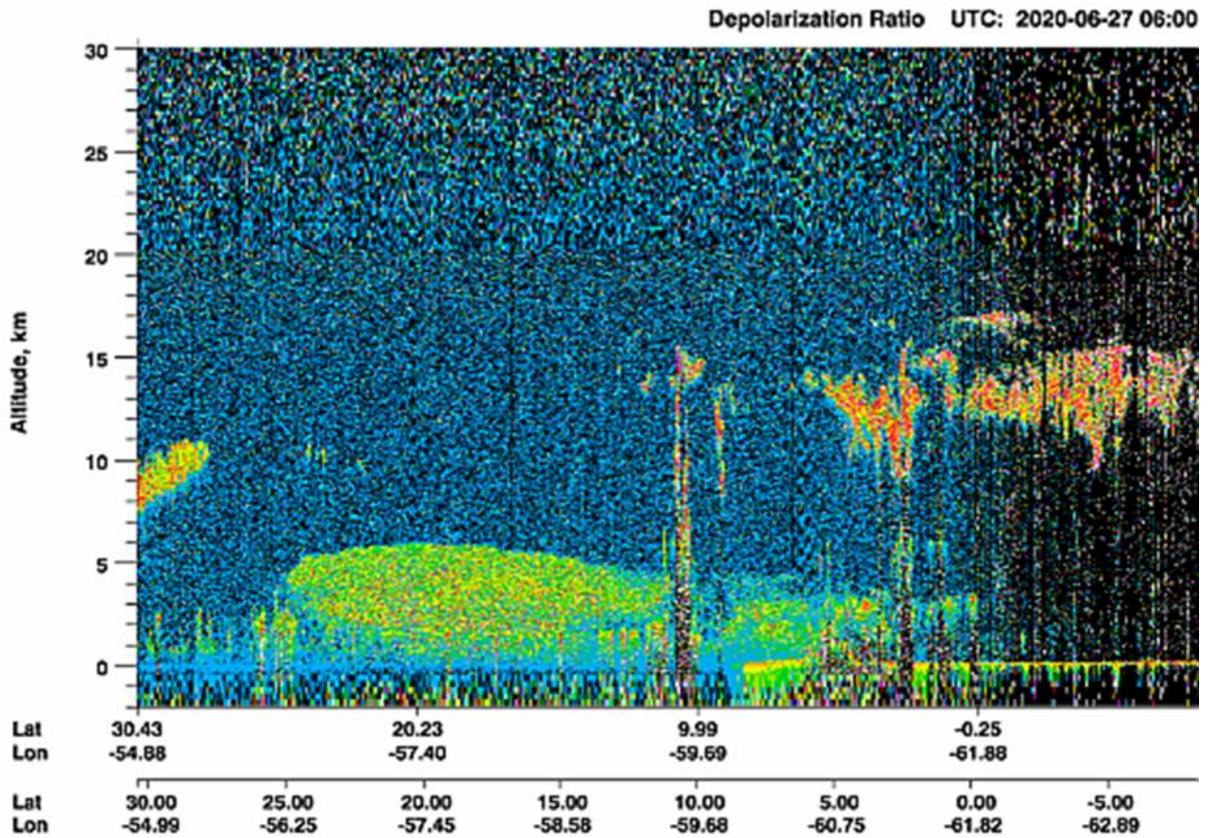
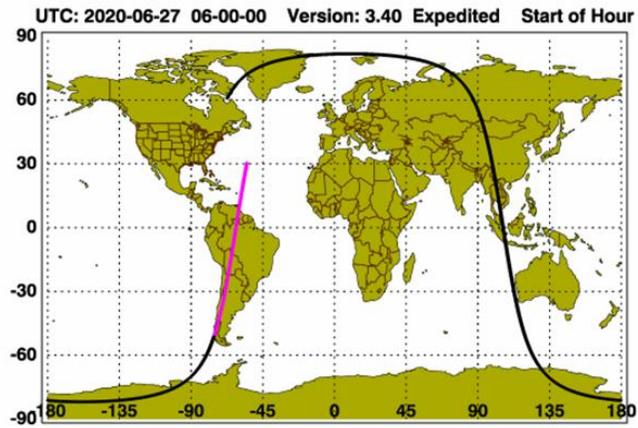


The CALIPSO track is shown in pink in the figure above and the aerosol depolarization profile along the track is shown below. The yellow-green color is specific for dust. The red oval shows the dust cloud of interest. The red arrow indicates the location of Miami along the track. Note that in the image, the profile suggests that there is little or no dust below the cloud. That is because of the attenuation of the beam by the thick layer of dust. Note that the dust cloud extends to about 34N, as far as the Carolinas. The altitude of the dust cloud is at about 5km. This is a bit high for a Saharan dust event in our region.



In the profile above, to the south of the elevated dust blob, we can see a large area of fuzzy-topped yellow-green which signifies dust. This is the northern edge of the westward-moving dust plume that is seen in the GEOS-5 model product shown above. South of the fuzzy dust area, there is a black-ed out region because of cloud. Immediately to the south of this, we see an elevated yellow-green area that tops out at about 7 km. This seems to be a very high elevated patch of dust. We seldom see dust that high in this region.

We also have a profile from a track to the east of the one shown above, made about an hour earlier.



This shows the main westward-moving cloud that is impacting the Windward Islands. Note that the top is at 6km, unusually high for the western Atlantic. Dust is seen extending to the region of the equator, albeit in a patchy mode. This places the dust over northern Brazil.

The PM10 Record over Florida, June 2020

In this section, based on the above background information, I attempt to assess the impact of the dust event on PM10 as it passed over Florida. In a separate PDF that I attach to this email, I present a display of the daily PM10 data over the month of June. These graphs are copied directly from the Florida Department of Environmental Protection.

<https://fldep.dep.state.fl.us/air/flaqs/SelectReport.asp>

In the document, I have stacked the PM10 record for all active stations in order, from the highest latitude to the lowest, a total of eleven. Alongside the plot, I insert a brief note that provides some information about the locations of the site. Some are in the midst of urban areas, for example, the Miami Fire House site located in downtown Miami and the Kooker site in downtown Jacksonville. Others, like Fort Walton Beach, located in the extreme western panhandle, are in a relatively isolated area. I make some general observations.

First, there appears to be a rather uniform background PM10 level of about $15 - 20 \mu\text{g m}^{-3}$ across all the sites. Second, many of the prominent “bumps” in the time series are concurrent in all the records. This suggests a large scale source is impacting the values, e.g., African dust. That is most obvious for the peak around 26 – 27 June, the days when the dust cloud was visible over the area in satellite images.

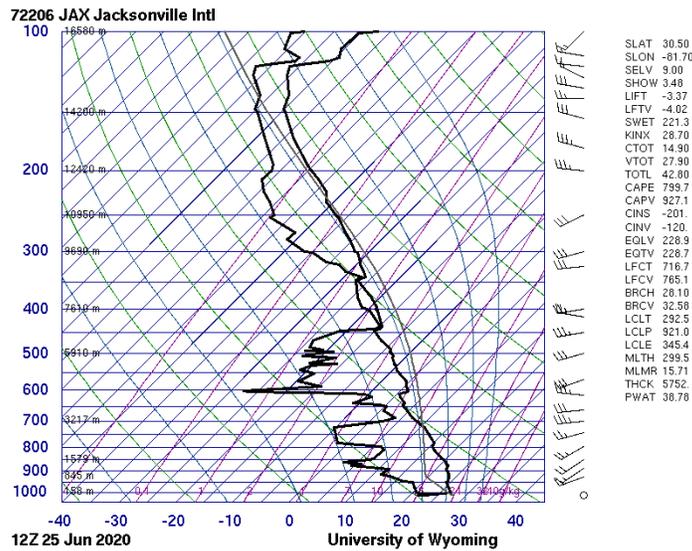
However, there is a distinct difference in the height of the peak (or bump) across the network. The peak is greatest and almost identical in shape at Kooker Park (max., $100 \mu\text{g m}^{-3}$), Mandarin ($80 - 90 \mu\text{g m}^{-3}$), Gardinier ($100 \mu\text{g m}^{-3}$, identical to Kooker). Palatka spiked to about $90 \mu\text{g m}^{-3}$ on one day. Many of the sites show a plateau of about $40 \mu\text{g m}^{-3}$ over the period 27 – 29 June.

Simply put, the dust event added a minimum of $20 \mu\text{g m}^{-3}$ to the PM10 environment over the entire state of Florida. Recall that when the cloud passed through the Windward Islands on 21 – 22 June, the concentrations were on the order of a couple of hundred $\mu\text{g m}^{-3}$ for extended periods of time. Thus the dust load was reduced by about a factor of ten during the 5 – 6 day journey from the islands to Florida. I would suspect that rain was largely responsible because dry-deposition is very inefficient for particles of the size of African dust over the Caribbean where the mass median diameter is about 2 micrometers.

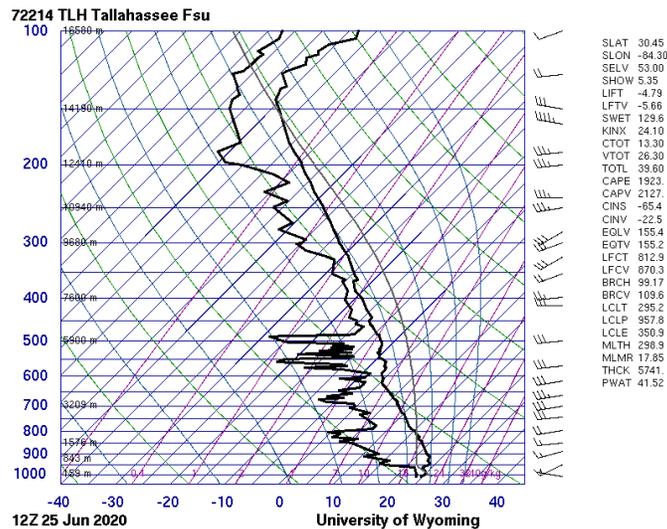
Note that three of the stations that spiked on 27 – 28 June (Kooker, Mandarin and Palatka) are located in the Jacksonville area. The fourth station, Gardinier, is located in Tampa, 300 km to the South. The only plausible explanation for this is that in these locations, vertical mixing was strong enough to tap into the SAL above the sites. I have looked at sondes from the five sonde stations in Florida:

Jacksonville, Tallahassee, Tamp, Miami, Key West. At various times one sees the signature of the SAL at these sites but the profiles are generally far from the canonical SAL. I don't want to go into too much detail here. But I will show one sounding from Jacksonville where PM10 climbed sharply on 25 June and plateaued on 26 – 27 June. It then dropped sharply to background ($20 \mu\text{g m}^{-3}$) on 29 June.

Here is a profile on 25 June:

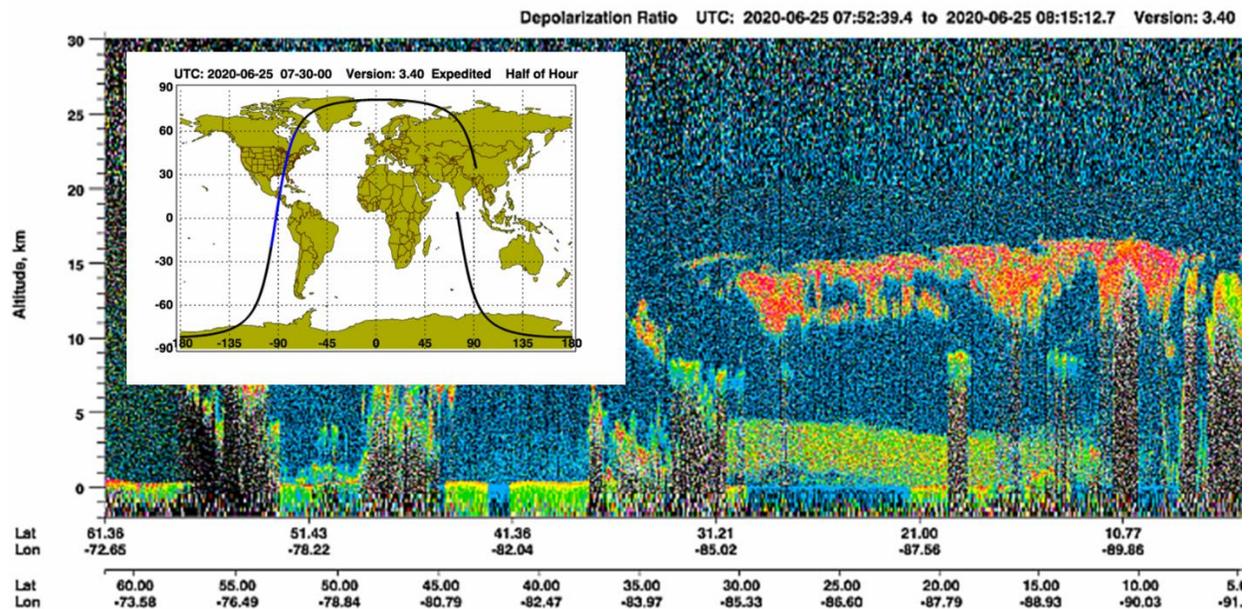


Note a very dry layer extends from the surface to above 3 km where the mixing ratio is down to 4 gm/kg. Above that, there is a second dry layer that extends to 6 km. Similarly, at Tallahassee we see a deep dry layer, but not as dry as at Jacksonville. The layer extends almost to the surface:



At Tallahassee, at the surface, there is a shallow layer that is quite moist as we would normally expect in Florida at this time. Note that at both sites, the sondes show extremely strong westerly winds up to 100mb!

On that day, CALIPSO passed almost directly over Tallahassee. CALIPSO shows an extremely dense layer of dust extending from the surface (apparently) to 4.5 km. Note that this profile also shows heavy dust extending to the south reaching Central America and crossing into the Pacific.



As you can see in the PM10 records, PM10 does not exceed the EPA 24-hour standard, $150 \mu\text{g m}^{-3}$ (the line drawn at the top of the figure) at any of the 13 sites. However, in those examples where a prominent peak was observed (Kooker, Mandarin, and Gardinier), the WHO 24-hour guideline ($50 \mu\text{g m}^{-3}$) was exceeded for about 2 days.

Conclusions:

1. African dust does impact air quality over Florida.
2. Despite the unusually intense nature of this event, it did not cause any exceedances of the EPA air quality standards although it did lead to exceedances of the WHO guideline.
3. The PM10 measurements made in air quality networks, supported by other evidence, can be used to map the impact of African dust events as they move across the Caribbean and the Southern US.