Research Article

Record-breaker African Dust hits the Gulf Coast during the Covid-19 Pandemic

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A once in a lifetime huge dust cloud traveling from Africa settled in the Gulf at the beginning of the summer 2020, setting the conditions for a perfect dry storm for Covid-19, one that will change the perception of African dust plumes forever.

If you've followed the Florida newspapers during the second half of June 2020, you surely will remember a series of headlines that, at the time, were competing with the daily Covid-19 counts for reader's attention. I list here a short selection thereof:

"African Dust Heading to Gulf Coast" (17 June), "Saharan dust could bring vibrant sunrises, sunsets to Central Florida" (18 June), "Saharan Dust dominates the Atlantic, keeping storm development low" (22 June), 'Godzilla dust cloud' travels 5,000 miles from Sahara to finally arrive to the US (28 June), or, a last one, "Florida's summer hurricane shield set to fade into the wind" (11 August).

THE MONSTER CLOUD

It was fifteen days to remember. According to the experts, it was the "dustiest" plume on record — bigger than the continental U.S. — that created a summer lull that kept storms from forming[1] (figure 1). The Saharan plume caught the attention of the whole nation and, thus, on June 29, you could read the following in the Washinton Post: "Last week's plume was arguably one of the most, if not the most, extreme events on record from a dust-transport standpoint. Joe Prospero, the atmospheric scientist and professor emeritus at the University of Miami, said the episode will be studied for years to come."[2]. You could also read from the reporter: "The Saharan Air Layer was our summer friend, helping disrupt the conditions that develop Atlantic storms.". This reporter, as many other technical and lay people alike, was certainly not aware of the fact that his statement would probably be remembered as another historic irony from this pandemic...

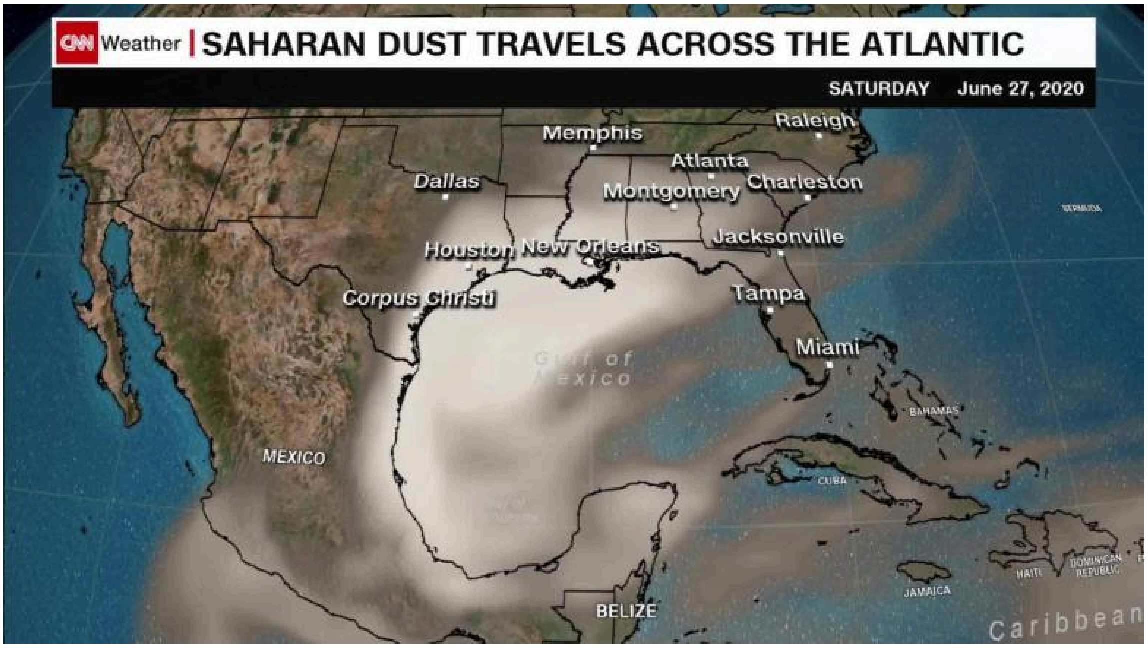

Figure 1

A few sentences down the text, you will see what I mean by that. But first, a little delving into the historical context of the phenomenon.

As much as it was a record breaking one this year, the phenomenon of Saharan dust arriving to American coasts was not new to the locals on the Gulf Coast nor, least of all, to the experts. Arguably, the dusting over millions of years has resulted in coloring the soils throughout Florida with red hues from the small amounts of iron laced in the fallout[3].

Since 1970, dust outbreaks have worsened due to periods of drought in Africa as well as to other more complex factors. Early research has even postulated the existence of the Saharan air layer (SAL)—a hot, dry, elevated layer within which the highest dust concentrations are usually found[3].

But what is the African dust cloud anyway? Back in the seventies the phenomenon was starting to catch the attention of meteorologists on both sides of the Atlantic[4]. Since the fifties, there was a long standing drought in the Sahel that was creating a mass of sandy material that was moving away in the west direction by trade winds across the Atlantic[5]. In the last two or three decades, the phenomenon has been observed even in humid African years, leading experts to conclude that factors other than drought would be involved in the generation of spring-summer plumes in the Atlantic[5].

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There is a large variability in the dust transport to the Caribbean and Florida from year to year. It is believed that African dust affects climate in the U.S. Caribbean[3][6]. The dust particles are so fine that they can penetrate human respiratory systems and cause serious breathing problems. Some of Prospero's earlier work found that African dust contributes to concentrations of bacteria and fungi. Other researchers suspect that airborne dust can carry plant viruses, such as the tobacco mosaic virus [7][8].

THE COVID-19 CONNECTION

But I wouldn't be writing here if I thought that there wasn't a tie with the pandemic, right? As I remember it, after reading the news headlines from late June, I suddenly made the connection with a piece of data that had puzzled me of late. I had previously read an early paper showing a striking correlation of Covid-19 related deaths with measured levels of nitrogen dioxide gas (NO2) in the troposphere (Ogen, 2020)[9]. This wasn't the first time that a correlation of Covid-19 data with man made pollution had been established[10][11][12]. It was however the first in linking a particular molecular moiety (NO2) with Covid-19 related deaths. Since I keep postulating that deaths (and more particularly deaths per capita or *dpm*) is the relevant data in the pandemic, I was pleased to read such a paper. *Dpm* is so relevant because it is the closest proxy to the Severe Acute Respiratory Syndrome (SARS) , and SARS, being more than a complication of CoV2 viral infection, is rather a different disease, in which the virus plays a more secondary role than the central one that have been given to it by the experts. The Ogen paper I refer to analyzed data from the heavily hit area of Northern Italy, showing a clear correlation of Covid-19 related deaths with compound yearly levels of NO2 in the troposphere, so, following the same logic, I looked for similar data in the US. What I found is shown in figure 2.

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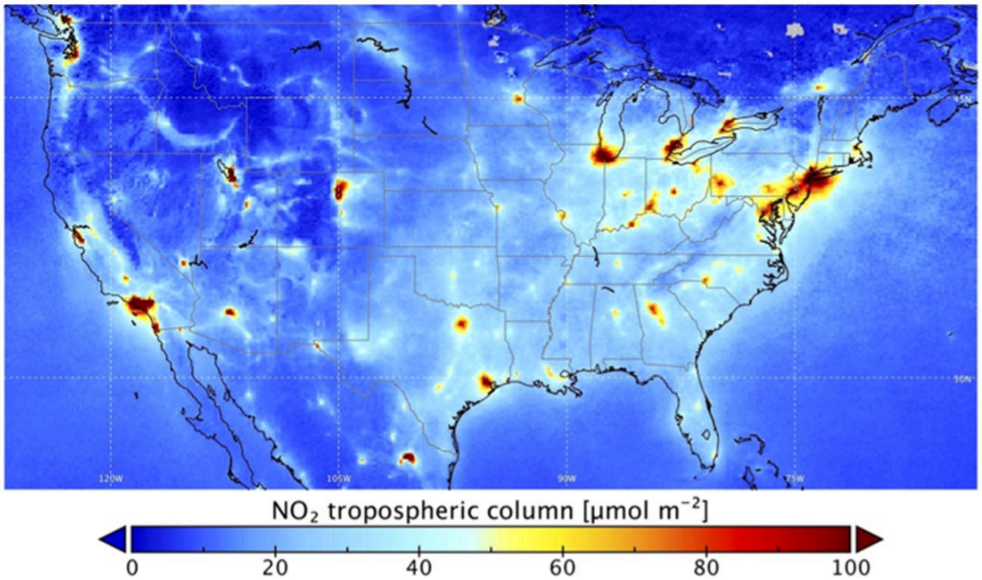

Figure 2

Average TROPOMI columns for tropospheric NO2 over the contiguous United States between 1 December 2018 and 31 March 2019. Retrieved columns have been binned on a 0.1° × 0.125° latitude-longitude grid for this analysis. From de Gouw et al. 2020[13]

As we can see, the hot spots of NO2 high concentrations almost exactly overlap with the Covid-19 higher death spots (LA in California, the NorthEast USA, and the Great Lakes.). It was a perfect overlap. Or was it?

As a matter of fact, it wasn't. In that map, there was a revealing absence of high NO2 emission hot spots in a particular area of the USA. To the trained eye, it is obvious that I am alluding to the US Gulf Coast. It was mid August and deaths were swarming up in most of the Gulf States in what looked as an untimely second SARS wave (figure 3). By then, most of the, until then, badly hit Areas, like the Northeast or the Great Lakes, were showing a receding or outright flat death rate curve.

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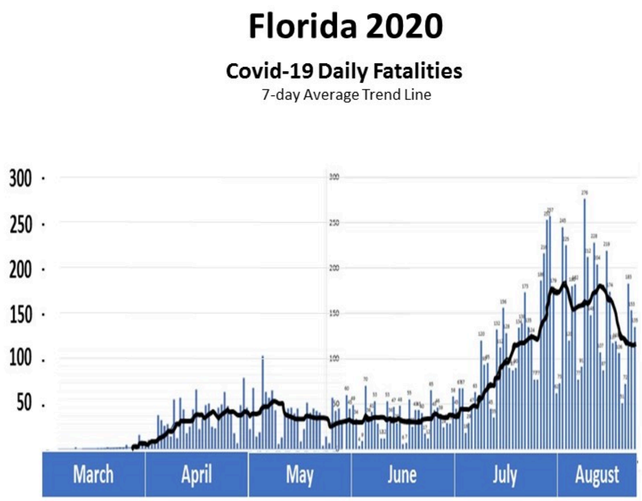

Figure 3

So, what was suddenly wrong with the Gulf? The region is notorious for its sticky humid weather and, remember, most virologists will tell you that respiratory viruses don't like humid air! In addition, as shown in Figure 2, the region has much less man made pollution (as measured by the NO2 atmospheric levels) than the Covid-19 hardest hit areas of continental USA, like the NorthEast, or the Great Lakes.

Nothing seemed therefore to fit with this early summer pandemic surge in the Gulf. Nothing, of course, until recently, when I came across the news of the Godzilla-like dust cloud. And now, only by looking at the picture in figure 4, I am pretty sure, this is something potentially important. Indeed, I believe the plume could alone explain the Covid-19 Gulf mystery, another piece of the global puzzle.

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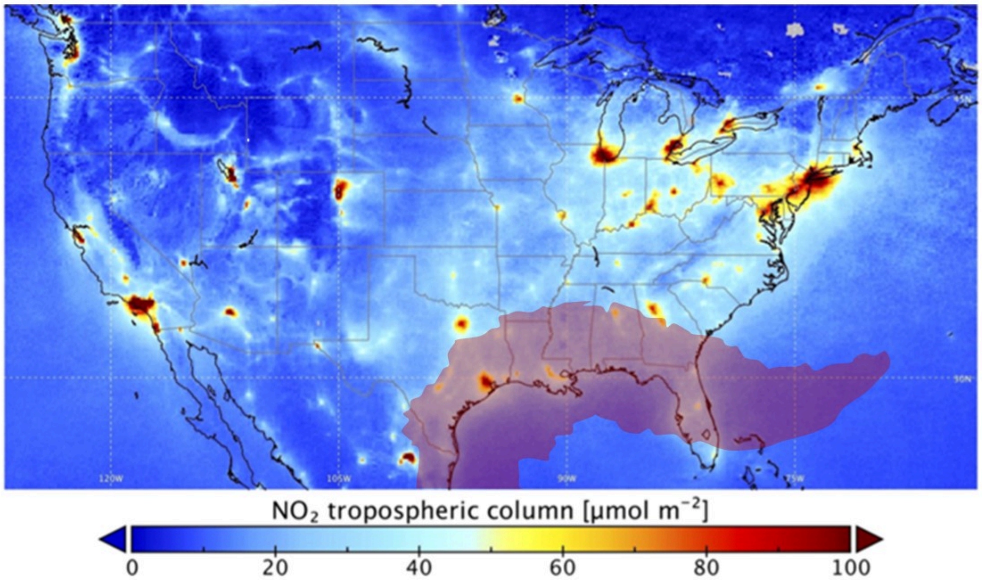

Figure 4

As it happens, after reviewing the literature as a dilettante meteorologist, I am coming to the provisional conclusion that this kind of dust clouds might be the closest thing to a "perfect (dry) storm" for SARS: 1) it creates a hot and dry tropospheric layer over the region, a layer that is slowly moved around by mild winds, and, perhaps more importantly, 2) it brings a two weeks long regular downfall of particles[14]: mineral nanoparticles, silica (i.e. aluminum silicates) micro particles[15][16], phosphate[17], iron[18], heavy metals like lead or mercury[19][20][21], arsenic and cadmium[22], briefly, all the gamut of inhalable particles, most of them chemically active after 5000 miles/1 week trip over the ocean, a process called *molecular aging*[23].

Indeed, in the context of *molecular aging*, dust is reactive with trace atmospheric gases, and these reactions impact greenhouse gases, aerosols, and air pollutants[24][25][26]. *Chemical aging* is also thought to increase the solubility of dust particles, thereby dramatically enhancing their water uptake properties and transforming dust from poor Cloud condensation nuclei (CCN) to efficient CCN. A classic example is the way *chemical aging* of dust converts the slightly soluble mineral calcite (calcium carbonate) to the highly hygroscopic calcium nitrate, which is a more efficient CCN[27]. All in all, the trip across the ocean might explain the differences in composition (and maybe the different effects on

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human health) between mostly land dust travel (Africa --> Europe, Asia--> Asia) and the transoceanic (Africa --> America) migration of dust clouds.

Although still in the hypothesis camp, the simple chronological association of the two events shown in this paper (a record breaking dust cloud hitting the Gulf Coast over the last week of June 2020 and the first week of July 2020, and the Covid-19 related death upsurge a few weeks later (figure 5)), provides more than enough evidence to start nurturing a more general theory, one that could explain the puzzling divorce between viral load and SARS in the Covid-19 pandemic[28].

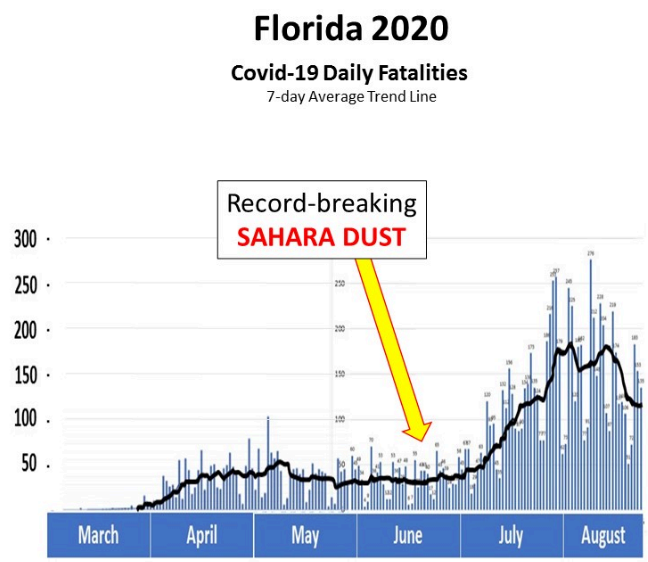

Figure 5

MECHANISM OF ACTION

Here the question: How pollution , in this case in the form of chemical dust, can influence the course of the Covid-19 disease? Well, presumably, particles in the downfall of a dust cloud are acting, either as a trigger or as an adjuvant, to tilt the balance of inflammation in the alveolar-endothelial gas exchange interface of the lungs. Remember, this is not just inert sand from the Sahara desert. *Molecular aging* during the trans-Atlantic trip makes for a full ammo of chemically active particles of all sizes, most of them inhalable. Therefore, abundant components of the dust cloud like, for instance, dust aluminum, that have traditionally been used as inflammation enhancers in vaccines, could likely

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play a pro-inflammatory role in SARS [29]. Also, activated (cationic) nanoparticles, similar to the ones found in dust plumes, have been shown to be able to induce SARS-like lung injury. Interestingly, these nanoparticles are able to bind and inactivate ACE2[30], the same molecule that is the main receptor of the COV2 virus and the natural counterbalance of the pro inflammatory peptide angiotensin II. Importantly, studies using ACE2 knockout mice have demonstrated that ACE2 protects murine lungs from SARS[31]. Furthermore, SARS-CoV infections and the Spike protein of the SARS-CoV reduce ACE2 expression. Notably, injection of SARS-CoV Spike into mice worsens acute lung failure in vivo, which can be attenuated by blocking the renin–angiotensin pathway[32]. Finally, on a different note, as previously hypothesized[19], heavy metals like mercury in dust clouds could also act as triggers of the local inflammatory response as seen in the lungs of SARS patients.

TO SUMMARIZE

I showed here a striking association between two "once in a lifetime" phenomena: this late June's Godzilla-like dust plume, and the Covid-19 July-August death upsurge in the Gulf Coast. The association is sequential (i.e. with an about three weeks delay, the death upsurge follows the arrival of the dust cloud to the Gulf) and reveals an almost perfect overlap between the areas in the Gulf hit by the summer wave of the pandemic and the ones influenced by the dust cloud. Together, the data in this paper provides substance to the theory that a confluence of factors (the CoV2 virus, atmospheric pollution, host factors) could be needed to trigger SARS (in the right place, at the right time!). It also warrants future research to experimentally demonstrate the role of tropospheric chemistry in the development of SARS during the Covid-19 pandemic.

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