Is Arctic warming behind a monster Saharan dust storm?

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The Sahara Desert is the world's biggest source of dust and in 2020, it broke the June record for sending the largest and thickest dust cloud toward the Americas.

Amato Evan, an atmospheric scientist at Scripps Institution of Oceanography at UC San Diego, and colleagues have broken down the conditions that led to what some researchers call the "Godzilla" dust storm of 2020.

The June 2020 dust storm set records in terms of its geographic size and its aerosol optical depth—essentially a measure of its thickness determined by the ability of satellites to see through it. It reached an altitude of 6,000 meters (19,600 feet). In certain locations over the Atlantic Ocean, its thickness was double what had ever been recorded during the month of June during the history of the satellite record, which dates back to 1995.

The researchers analyzed what made it happen in a study appearing today in the journal *Geophysical Research Letters*.

Evan, lead author Diana Francis of Khalifa University of Science and Technology in the United Arab Emirates, and colleagues attributed the dust storm's magnitude to conditions set up by the development of a type of high-pressure system called a subtropical high off the coast of the Sahara. This increased the north-south pressure gradient over West Africa leading to record-strength, persistent northeasterly winds. The intensification of the northeasterly winds over the Sahara generated continuous dust emissions over several days in the second half of June 2020.

The researchers found that the subtropical high was embedded in a circumglobal wavetrain, a chain of wind patterns that extended around the planet, and was present in the Northern Hemisphere for most of June 2020. This wavetrain may have been caused by record-low Arctic sea ice extent observed in June 2020 as well. The warming of the Arctic region is believed to be altering the course of wind patterns in the mid-latitudes and subtropics and causing severe weather events, though there is

controversy among scientists about this concept.

"The development of the subtropical high off the African coast had a deterministic role in both dust emissions and rapid westward transport of the airborne dust across the tropical Atlantic," said Francis. "The clockwise circulation associated with the high, intensified the African Easterly Jet, a jet stream present over the Sahara around five kilometers (3.2 miles) in altitude, which rapidly transported the dust towards the Caribbean and southern United States."

The global travel of dust has myriad consequences, affecting everything from weather to aircraft travel to the fertility of soil on continents thousands of miles away from the source of the dust. The dust provides important nutrients such as iron and other minerals to ocean ecosystems as well. Dust is also thought to have an influence on tropical cyclone activity in the Atlantic Ocean through its effects on surface temperatures. Dust plumes are believed to cool the ocean surface by reflecting sunlight back to space, which in turn reduces the amount of energy available for a cyclone to form or intensify.

"While there is a large body of evidence suggesting that increased dust suspended over the Atlantic can reduce the numbers of tropical cyclones there, primarily through dust-induced cooling of ocean surface temperature, this year we observed the largest dust storm on record, as well as one of the most active hurricane seasons on record," said Evan. "Either 2020 is just a year where everything is upside-down, or we really need to reevaluate our understanding of how dust impacts that climate system."

Francis and Evan are planning to investigate in future work how the June 2020 storm affected the solar energy received in the atmosphere and on the planet's surface, and assess its impact on the tropical storm season of 2020.

The study also touches on a controversial topic within the science community. Though not the main focus of study, the wavetrain pattern that set the Godzilla dust storm in motion looked very similar to one observed in 2010 when sea ice in the Arctic Ocean was substantially diminished, Francis' team noted.

"As the Arctic sea-ice cover was rather low in June 2020, around the lowest on record in the period of satellite observations, it may have contributed to the observed large-scale anomaly pattern," the study concludes. "Thus, if such patterns become more common in a warmer world, it is plausible that these extreme dust outbreaks will increase in frequency in the future."

The anomaly pattern the study refers to is one in which Arctic winds meander, rather than blowing in more or less a straight direction. Sometimes the wind patterns dip far south of the Arctic, leading to exceptionally cold events in the United States and Europe. The meander sets off a chain of events that can alter the course of other common wind patterns.

There is controversy, though, among researchers about the effect that a warming Arctic Ocean is having. Some argue that the sequence is reversed, that shifting wind patterns are what warms the Arctic rather than the other way around. Others believe that the patterns observed during years when sea ice is diminished are still within the range of natural variability, as opposed to change caused by global warming.

More information: Diana Francis et al. The Atmospheric Drivers of the Major Saharan Dust Storm in June 2020, *Geophysical Research Letters* (2020). DOI: 10.1029/2020GL090102

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