New Research Links Smoke to Tornado Intensity

By Gary Galluzzo
February 2, 2015

Can smoke from fires intensify tornadoes?

“Yes,” according to a study led by Gregory Carmichael, a professor at the University of Iowa and a member of NASA’s Air Quality Applied Sciences Team (AQAST). The results of th study found that smoke produced from agricultural land-clearing fires in Central America was transported across the Gulf of Mexico and interacted with a severe storm, which produced a record number of tornadoes on April 27, 2011.

The storm produced 122 tornadoes, resulted in 313 deaths across the southeastern United States, and is considered the most severe event of its kind since 1950. The outbreak was caused mainly by environmental conditions leading to a large potential for tornado formation and conducive to supercells, a type of thunderstorm. However, smoke particles intensified these conditions, according to Carmichael and co-author Pablo Saide, a postdoctoral fellow at the Center for Global and Regional Environmental Research (CGRER).

They say the smoke lowered the base of the clouds and increased wind shear, defined as wind speed variations with respect to altitude. Together, those two conditions increased the likelihood of more severe tornadoes. The effects of smoke on these conditions had not been previously described, and the study, published in the journal Geophysical Research Letters, found a novel mechanism to explain these interactions.

“These results are of great importance, as it is the first study to show smoke influence on tornado severity in a real case scenario,” Carmichael said. “Also, severe weather prediction centers do not include atmospheric particles and their effects in their models, and we show that they should at least consider it.”

“We show the smoke influence for one tornado outbreak, so in the future we will analyze smoke effects for other outbreaks on the record to see if similar impacts are found and under which conditions they occur,” says Saide. “We also plan to work along with model developers and institutions in charge of forecasting to move forward in the implementation, testing and incorporation of these effects on operational weather prediction models.”

In order to make their findings, the researchers ran computer simulations based upon data recorded during the 2011 storm. One type of simulation included smoke and its effect on solar radiation and clouds, while the other omitted smoke. The simulation including the smoke resulted in a lowered cloud base and greater wind shear. Future studies will focus on gaining a better understanding of the impacts of smoke on near-storm environments and tornado occurrence, intensity, and longevity, Carmichael said.

The paper “Central American biomass burning smoke can increase tornado severity in the U.S.” can be found **here** and the University of Iowa story can be found **here**. AQAST member Brad Pierce and AQAST investigator Scott Spak were also co-authors of the study.

Sources and media coverage

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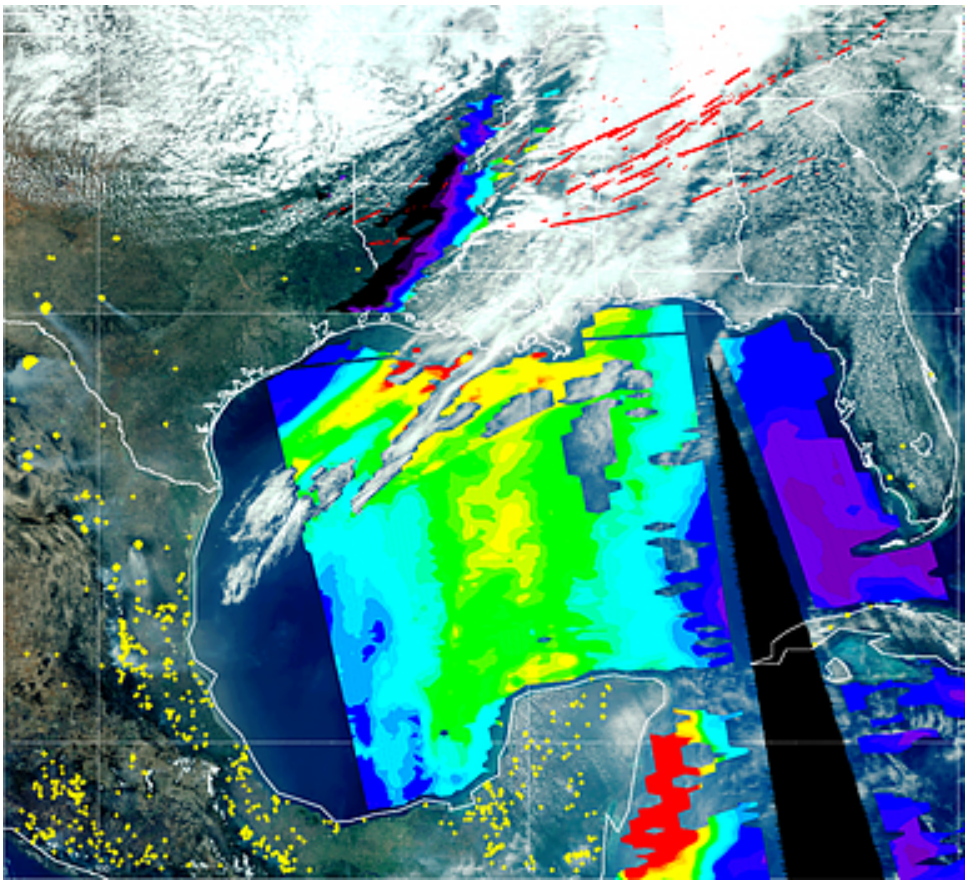

The satellite image for April 27, 2011 shows tornado tracks as red solid lines. The thickest lines indicate magnitude 5 tornados, descending to magnitude 1 for the thinnest. Yellow markers indicate fires, and an iridescent overlay shows particulate matter in the air, with red showing highest amount and purple the lowest. (Imagery courtesy of Brad Pierce, NOAA Satellite and Information Service Center for Satellite Applications and Research).