New Sensor Shows Electric Nature of Dust Devils

By Willie D. Jones

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Electric field sensor could help in climate studies and electronics manufacturing too

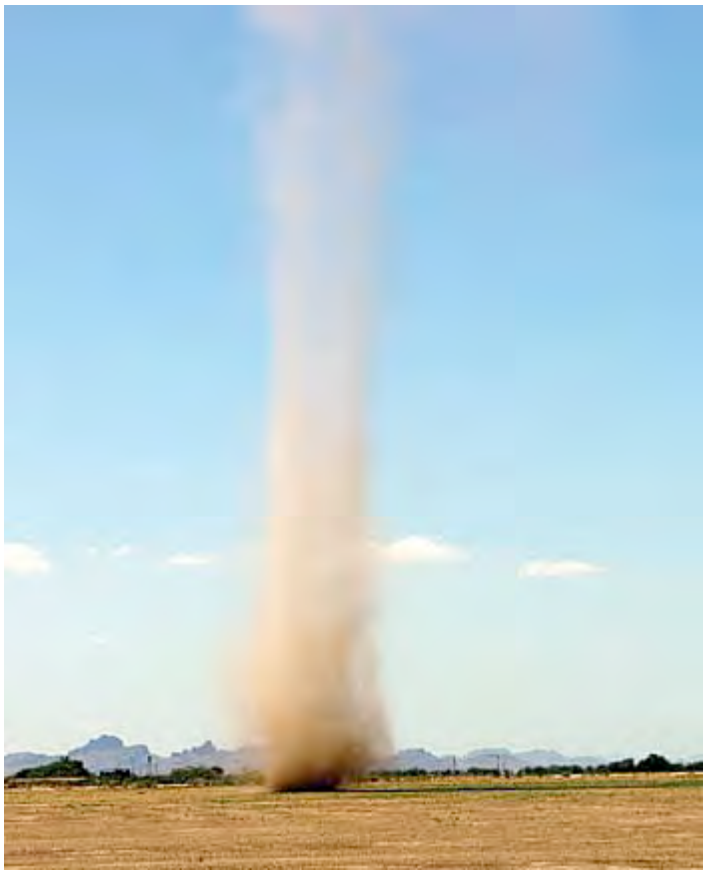

PHOTO: NASA

A team at the University of Michigan, in Ann Arbor, recently made a breakthrough that could help climate scientists fill in one piece missing from today's climate models. The group, led by Nilton Renno, has shown that electric fields as strong as 160 kilovolts per meter could double the amount of dust that makes it into the atmosphere. Dust is part of the family of aerosols—suspended particles or molecules in the air—which includes water vapor and soot from coal combustion. Aerosols absorb or reflect radiation, either warming or cooling regions of the earth.

Renno, an associate professor of atmospheric, oceanic, and space sciences, had predicted years earlier that electricity might be a missing link, when he noticed that dust devils, the spinning vortexes of air that look like miniature tornadoes, had strong electric fields. But he and Jasper Kok, a doctoral student, proved the extent of electricity's role in lifting dust into the air only after they created a new kind of electric-field sensor—one that measures a field's strength without disrupting the field and is immune to the effects of ion currents and the negative charges carried by wind-blown particles colliding with the sensor.

Though it remains unclear just how important natural dust is to climate change, Renno's work may yield another, largely unintended benefit. The sensor he and his colleagues developed for taking measurements on windswept sand dunes and dusty mesas is being tested for use inside semiconductor fabs. Renno reports that Flextronics—a Singapore-based firm that designs, fabricates, assembles, and tests electronics such as printed circuit boards—is determining the sensor's usefulness in

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detecting the buildup of electrostatic charge in clean rooms. Such discharges lower microprocessor yields. Kok notes that the sensor's value comes from its size, which is "an order of magnitude smaller than traditional sensors of this type, so it can get closer to possible sources of electric discharge."

The main component of the sensor, which Renno and his team have spent a few years developing, is a 22-millimeter-diameter, 150-mm-long rotating cylinder coated with silver conductive paint. The cylinder is divided lengthwise into two hemispheres that are connected by a wire. The sensor distinguishes between the effects of the ambient electric field and error-inducing airborne charged particles by measuring the amount of charge from both sources that moves from one hemisphere to the other as the cylinder rotates at 1000 revolutions per minute. It then takes another measurement at, say, 2000 rpm. Because the part of the signal that comes from the electric field varies in direct proportion to the cylinder's rotational speed, a 50 percent increase in the amount of charge pulsing through the wire after doubling the rotation speed means that half of the total charge measured at the slower speed was due to the electric field.

Renno, who continues to use the device to fill in blanks in the climate picture, says his team's next step is to build a database of readings taken at some of the world's most dusty regions. This will help them find answers to remaining questions, such as how ambient weather conditions like humidity affect the processes by which dust achieves liftoff.

But how important is natural dust in the overall aerosols picture? Ronald L. Miller, a senior scientist at the NASA Goddard Institute for Space Studies, in New York City, notes that until more historical data regarding the relationship between wind and dust accumulates, it will be impossible to tell whether the amount of natural dust in the air is having an effect on climate change in the same way that human-made aerosols like soot do.