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How Intense Will Storms Get? New Model Helps Answer Question

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Description

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Citations

A paper on the new model is published early online in the Swedish journal Tellus A.

Newswise — A new mathematical model indicates that dust devils, water spouts, tornadoes, hurricanes and cyclones are all born of the same mechanism and will intensify as climate change warms the Earth's surface.

The new equation, developed by University of Michigan atmospheric and planetary scientist Nilton Renno, could allow scientists to more accurately calculate the maximum expected intensity of a spiraling storm based on the depth of the troposphere and the temperature and humidity of the air in the storm's path. The troposphere is the lowest layer of Earth's atmosphere.

This equation improves upon current methods, Renno says, because it takes into account the energy feeding the storm system and the full measure of friction slowing it down. Current thermodynamic models make assumptions about these variables, rather than include actual quantities.

"This model allows us to relate changes in storms' intensity to environmental conditions," Renno said. "It shows us that climate change could lead to increases in how efficient convective vortices are and how much energy they transform into wind. Fueled by warmer and moister air, there will be stronger and deeper storms in the future that reach higher into the atmosphere."

Renno and research scientist Natalia Andronova used the model to quantify how intense they expect storms to get based on current climate predictions. For every 3.6 degrees Fahrenheit that the Earth's surface temperature warms, the intensity of storms could increase by at least a few percent, the scientists say. For an intense storm, that could translate into a 10 percent increase in destructive power.

Renno's model is what scientists call a "generalization" of Daniel Bernoulli's 18th-century equation that explains how airplane flight is possible. Bernoulli's equation basically says that as wind speed increases, air pressure decreases. It leaves out variables that were considered difficult to deal with such as friction and energy sources (which, in the case of a whirling storm, is warm air and condensation of water vapor.) And in certain idealized situations, omitting that information works fine.

But by including these additional variables, Renno was able to broaden Bernoulli's equation to apply it to more general phenomena such as atmospheric vortices.

"The laws of physics are generally very simple," Renno said. "When you make assumptions, you are not representing the simple, basic law anymore. If you don't make assumptions, your equations have those simple, basic laws in them. It gets a little more complicated to get to the solution, but you don't introduce error, and you answer is more elegant, more simple."

Renno's work bolsters studies by others who say hurricanes have grown stronger over the past 50 years as sea surface temperatures have risen. This effect has not been extreme enough for humans to notice without looking, scientists say. Hurricane Katrina and Cyclone Nargis were not the most intense storm to hit land in the past half century. Other factors contributed to the devastation they caused.

This new model helps explain the formation of spiral bands and wall clouds, the first clouds that descend during a tornado. It's clear now that they are the result of a pressure drop where the airspeed has increased.

Renno says unifying convective vortices from dust devils to cyclones will help scientists better understand them.

"This is the first thermodynamic model that unifies all these vortices," he said. "When you unify them, you can see the big picture and you can really understand what makes them form and change."

A co-investigator on NASA's Mars Phoenix Lander mission, Renno has used his new model to calculate the intensity of dust storms in Mars' polar regions. He found that at the Phoenix landing site dust storms can have winds in excess of 200 mph.

Renno is an associate professor in the Department of Atmospheric, Oceanic and Space Sciences. Andronova is a research scientist in the Department of Atmospheric, Oceanic and Space Sciences.

A paper on the new model is published early online in the Swedish journal *Tellus A*. The paper is called "A Thermodynamically General Theory for Convective Vortices." It is available at: http://www3.interscience.wiley.com/journal/119879028/abstract

For more information:

Nilton Renno: http://www.ns.umich.edu/htdocs/public/experts/ExpDisplay.php?ExpID=1107

Michigan Engineering:
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