Bolts Of Blue Lightning Thrusting Upward And Other Weird Lightning Explained

ScienceDaily (Mar. 30, 2008) — The mechanism behind different types of lightning may now be understood, thanks to a combination of direct observation and computer modeling reported by a team of researchers from New Mexico Tech and Penn State.

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Most people see lightning strikes that go from clouds to the ground, but some lightning goes upward, forming blue jets and gigantic jets. Perhaps the most dangerous lightning appears as "bolts from the blue"—lightning that begins upward, but then moves sideways and then downward to hit the ground as much as three miles from a thunderstorm.

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About 90 percent of lightning occurs inside clouds and is not visible to the casual observer. The researchers wondered if lightning that appears within clouds and the lightning that escapes upward or downward shared the same development mechanisms.

"With the help of colleagues from New Mexico Tech, we were able to build a model of lightning and apply it to the various types of lightning," says Jeremy A. Riousset, graduate student in electrical engineering, Penn State. "Thanks to their observations and measurements, we know how lightning like 'bolts from the blue' happen. We know they develop like normal intracloud lightning before escaping the thundercloud at upper levels and branching toward the ground."

They also discovered that upward and sideways lightning events occurred shortly after normal downward lightning bolts occurred or intracloud lightning produced a local charge imbalance in the cloud.

Harald E. Edens, graduate student in physics, New Mexico Tech, working with Paul R. Krehbiel, professor of physics; Ronald J. Thomas, professor of electrical engineering, and William Rison, professor of electrical engineering, all at New Mexico Tech; and Mark A. Stanley, consultant, obtained normal optical photography or videography cannot do.

Mapping Array can map lightning within clouds, something that normal optical photography or videography cannot do. Riousset, working with Victor P. Pasko, associate professor, electrical engineering at Penn State, looked at the images from New Mexico Tech's Lightning Mapping Array, a three-dimensional lightning location system that uses multiple measurement stations to capture and time the VHF signal of the lightning. The Lightning Mapping Array can map lightning within clouds, something that

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jets," says Pasko.

In normal thunderstorms, blue jets are positive, originate in the uppermost part of the cloud and propagate continuously upward; while gigantic jets are negative, begin like a normal intracloud flash and propagate stepwise upward. Inverted polarity storms do exist and the charges of the various lightning types would then reverse.

The higher the cloud, the more likely either type of jet becomes. Thunderstorms in the tropics form with very high clouds increasing the chances of jets forming. Thunderstorms in the temperate United States do not have clouds quite so high, allowing a great number of bolts from the blue to occur. Bolts from the blue are very common in continental mid-latitude storms.

Every discharge of lightning from the cloud alters the charge status within the cloud, shifting the locations of the highest negatively or positively charged areas. These shifts along with mixing of the upper areas of the clouds can tip the storm toward bolts from the blue or jets depending on the circumstances.

"We are proposing a self-consistent, unified theory of lightning discharges inside and outside of clouds including blue jets, bolts from the blue and gigantic jets," says Pasko of Penn State. He adds that while their model can stipulate the requirements of each type of lightning, data collection during storms is too slow for the model to act in any predictive way.

The National Science Foundation supported this work.

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