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Press Release 12-081

Scientists Across U.S. Launch Study of Thunderstorm Effects on Upper Atmosphere

Research examines how thunderstorm structure and cloud chemistry interact



Thunderstorms and lightning play a key role in the chemistry of our atmosphere.

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May 1, 2012

Scientists are targeting thunderstorms in Alabama, Colorado and Oklahoma this spring to discover what happens when clouds suck air many miles into the atmosphere from Earth's surface.

The Deep Convective Clouds & Chemistry (DC3) Experiment, which begins in mid-May, will explore the influence of thunderstorms on air just beneath the stratosphere, a region that influences Earth's climate and weather patterns.

Scientists will use three research aircraft, mobile radars, lightning mapping arrays and other tools to pull together a comprehensive picture.

"We tend to associate thunderstorms with heavy rain and lightning, but they also shake things up at the top of the cloud level," says National Center for Atmospheric Research (NCAR) scientist Chris Cantrell, a DC3 principal investigator.

"Their effects high in the atmosphere in turn have effects on climate that last long after the storm dissipates."

While past field projects have focused on thunderstorm details with only some chemistry information, or on chemistry with limited data on storms, DC3 is the first to take a comprehensive look at both chemistry and thunderstorm details, including air



Spring thunderstorms are on the horizon for much of the U.S. midwest and other areas.

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Where there are thunderstorms this spring, DC3 scientists will be on the trail.

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The chemistry of lightning and its role in atmospheric processes is central to DC3.

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look at both chemistry and thunderstorm details, including air movement, cloud physics and electrical activity.

The scientists leading the project are from NCAR, Penn State University, Colorado State University, and the National Oceanic and Atmospheric Administration (NOAA), with involvement by more than 100 researchers from 26 organizations.

Funding for DC3 is from the National Science Foundation (NSF), NOAA and NASA.

One of the key goals of DC3 is exploring the role of thunderstorms in forming upper-atmosphere ozone, a greenhouse gas that has a strong warming effect high in the atmosphere.

"The internal structure of thunderstorms and the lightning that accompanies them differs considerably across the country," says Brad Smull, director of NSF's physical and dynamic meteorology program. "That in turn affects the chemical processes inside these storms."

When thunderstorms form, air near the ground has nowhere to go but up, says NCAR scientist Mary Barth, a principal investigator on the project. "Suddenly you have an airmass at high altitude that's full of chemicals that can produce ozone."

Ozone in the upper atmosphere plays an important role in climate change by trapping significant amounts of energy from the sun.

However, ozone is difficult to track because, unlike most greenhouse gases, it is not directly emitted by either pollution sources or natural processes.

Instead, sunlight triggers interactions between pollutants such as nitrogen oxides and other gases, and those reactions create ozone.

These interactions are well understood at the Earth's surface, but have not been measured at the top of the troposphere, the lowest layer of the atmosphere just below the stratosphere.

Updrafts in thunderstorm clouds range from about 20 to 100 miles per hour, so air arrives at the top of the troposphere, about 6 to 10 miles up, with its pollutants relatively intact.

The polluted airmasses don't keep rising indefinitely because of the barrier between the troposphere and stratosphere, called the tropopause.

"In the mid-latitudes, the tropopause is like a wall," says Barth. "The air bumps into it and spreads out."

The DC3 scientists will fly through these plumes to collect data as a storm is underway.

They'll fly again the next day to find the same air mass, using its distinctive chemical signature to see how it has changed over time.

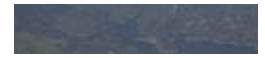
Pollution isn't the only source of nitrogen oxides, the ozone precursor. Lightning strikes also produce nitrogen oxides.

"We are pretty sure lightning is the largest natural source of nitric oxide," says NOAA National Severe Storms Laboratory scientist Don MacGorman. "It is important to know the naturally occurring contribution."

The DC3 investigators are looking at three widely separated sites in northern Alabama, northeastern Colorado, and central Oklahoma to west Texas.

All three sites have existing weather instrumentation on the ground, including dual-Doppler research radars, lightning mapping arrays, and balloon launches to measure the state of the atmosphere from the ground to the stratosphere.

Scientists at each of the sites will combine data from radars with Doppler capabilities (for wind information) and polarimetric



NSF/NCAR's Gulfstream V research aircraft will perform much of the high-altitude work in DC3. [Credit and Larger Version](#)



DC3 scientists will fly into the hearts of thunderstorms. [Credit and Larger Version](#)

capabilities (for wind and cloud particle information) with lightning mapping arrays.

The results will improve understanding of how storms produce lightning, and of how to use lightning mapping data to improve storm forecasts and warnings.

The three research aircraft will be based at Salina Municipal Airport, Kan., a location central to all three study areas. Each day, they will fly to whichever area has the most promising forecast for thunderstorms suitable for study.

The NSF/NCAR Gulfstream V research aircraft will do the bulk of the high-altitude measurements.

Simultaneously, a NASA DC-8 will fly as low as 1,000 feet above the ground, measuring air flowing into the clouds at their bases as well as the chemistry of surrounding air.

The third research aircraft, a Dassault Falcon 20E operated by the German space agency will join DC3 for three weeks and fly especially close to storm cores at high altitudes.

The multiple sites will enable the scientists to study different types of atmospheric environments.

Alabama has more trees and thus more natural emissions; the Colorado site is sometimes downwind of Denver's pollution; the Oklahoma and west Texas site may offer clean air.

"The more different regions we can study, the more we can understand how thunderstorms affect our climate," Barth says.

Alex Pszenny, NSF program director for atmospheric chemistry, adds: "The simultaneous chemistry measurements from three of the world's most sophisticated research aircraft--combined with data from state-of-the-art radar and lightning sensor technology--will give DC3 scientists the opportunity to make major advances in understanding these chemical processes."

-NSF-

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Related Websites

DC3: Deep Convective Clouds & Chemistry Experiment:

<http://www.eol.ucar.edu/projects/dc3/>

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