Collecting new data on atmospheric particles for storm forecasting and climate models

October 13 2021, by Katie Elyce Jones

TRACER installation of the ARM mobile facility in La Porte, Texas, outside of Houston. Credit: ARM

For decades, scientists have debated the impact of human-made and environmental particles in the atmosphere, called aerosols, on severe weather. Climate studies suggest aerosols may help shape and even

strengthen elements of storms such as rainfall and lightning.

However, studying aerosols in the atmosphere is difficult. There are many types, and the particles are small. Their chemical and physical processes can also be subtle or short lived. Scientists have voiced the need for more detailed data on aerosols. New data are especially needed to improve the representation of clouds and storms in climate models.

To provide these important data for scientists, policymakers, and the public, the Department of Energy's Office of Science is supporting a team of researchers who are scanning clouds in the Texas sky at high resolution. By tracking aerosols and clouds in this way, the team hopes to better understand the relationship between the particles, clouds, and storms.

DOE's mobile atmospheric observatory

A new project called TRACER—Tracking Aerosol Convection Interactions Experiment—is using a DOE mobile observatory from the Atmospheric Radiation Measurement (ARM) user facility to record micro processes happening in clouds. The experiment runs from October 2021 to September 2022 in the Houston area.

The ARM observatory consists of portable shelters outfitted with instruments and communications equipment. The observatory site may look inconspicuous—but it is one of the world's most advanced facilities for collecting atmospheric data.

The Office of Science's Biological and Environmental Research (BER) program manages several ARM observatories as a multi-laboratory user facility. For over 30 years, research campaigns have taken these mobile stations to the frontiers of climate and atmospheric science—from the South Pole to the North Pole to the tropics. The data collected from

these field expeditions help improve climate model predictions.

Advancing our understanding of aerosols

Aerosols are human made and natural particles that make their way into the atmosphere. Human-made aerosols may include pollutants emitted from automobiles or industrial plants. Natural aerosols may include sea salt, dust, wildfire smoke, and other particles from the environment, either nearby or carried hundreds of miles by wind and weather.

"One of the major questions of the TRACER campaign is the extent to which atmospheric aerosols can make storms more severe," said Shaima Nasiri, BER Atmospheric System Research program manager.

Connecting the dots between small particles and storms is a complex problem. Fortunately, solving multiscale problems such as this one, spanning fundamental chemistry to global climate modeling, is a specialty of the Office of Science.

TRACER is led by DOE's Brookhaven National Laboratory principal investigator Michael Jensen, with many co-investigators across other DOE national laboratories, the University of Houston, and scientists around the globe. The one-year campaign will focus on aerosols found in deep convective clouds—a common type of storm cloud.

"Convective clouds act as the elevators of the atmosphere," Jensen said. "They're vertically developed and tend to transport water vapor, heat, momentum, and particles from the surface up to the atmosphere."

To better observe aerosol and cloud interactions across time (minutes to months) and space (small particles to storm clouds), the TRACER team added new tools to ARM's suite of sensors, weather balloons, and radar.

New scanning and artificial intelligence techniques will automatically track clouds as they develop. Then, specialized radar systems will make detailed measurements of clouds and particles.

"We will also collect aerosols on the surface to measure their size and number," Jensen said.

These tools will lend precision techniques from the laboratory to field observations.

Houston—A real-world cloud laboratory

If you're a scientist studying aerosols in convective clouds, Houston is a good place to do your work. The region's subtropical climate on the Gulf of Mexico experiences predictable heavy rainfall, storms, flooding, and even hurricanes. Convective clouds hover over the city half the year and are more frequent in the wet, summer months.

Houston is also a thriving city with shipping and industry—and the aerosols that come with it. The metropolitan area ranks high among U.S. cities for poor air quality, including particle pollution. But the sprawling Texas landscape around the city boasts clearer air, providing a laboratory-like control environment for comparison.

Houston is also a typical American city. About 80 percent of Americans live in urban areas and about 40 percent live on the coast.

"The majority of people in the United States live in cities like Houston," Nasiri said.

While many ARM mobile observatories have been deployed in remote environments vulnerable to climate change, TRACER may serve as a model for future ARM urban campaigns.

"I think the technology has advanced to the point that scientists feel they can make progress on the pressing questions in atmospheric sciences related to urban impacts," Nasiri said.

As cities like Houston can attest, climate change impacts hit closer to home than ever. Devastating storms can lead to loss of life, dangerous power outages, and costly property damage.

"This is our first major urban field campaign of its kind, and going forward, we're interested in more closely studying emissions in cities," said Jeff Stehr, BER Atmospheric System Research program manager.

Long-lived data for future climate studies

Available to anyone to use, TRACER data will be an important resource for scientists and communities for years to come. Although the campaign is based on fundamental science questions about aerosol interactions, the BER program expects TRACER data will inform other studies. Scientists may use the data in research ranging from basic science on aerosol chemistry to pollution, extreme weather, and climate change and resiliency. The program itself will fund basic science research using TRACER data after the campaign is complete.

"We've also had a lot of interest from other agencies, with a diversity of people participating," Jensen said. "The initial science team included 35 co-investigators, but it has grown to a much larger partnership with interagency and international collaborators."

To maximize data gathered and pool the results, other U.S. science agencies, including NASA, NOAA, and the National Science Foundation, will conduct their own atmospheric experiments during the TRACER campaign. Regional organizations, such as the Texas Commission on Environmental Quality, are also collaborating with the

project.

With many potential uses for TRACER's high-resolution climate data, research results could go beyond the study of aerosol and cloud interactions.

"We may not even know what the biggest outcome of the campaign is going to be," Nasiri said. "The biggest takeaway could be something we're not even thinking about."

Provided by US Department of Energy

Citation: Collecting new data on atmospheric particles for storm forecasting and climate models (2021, October 13) retrieved 25 April 2024 from https://phys.org/news/2021-10-atmospheric-particles-storm-climate.html