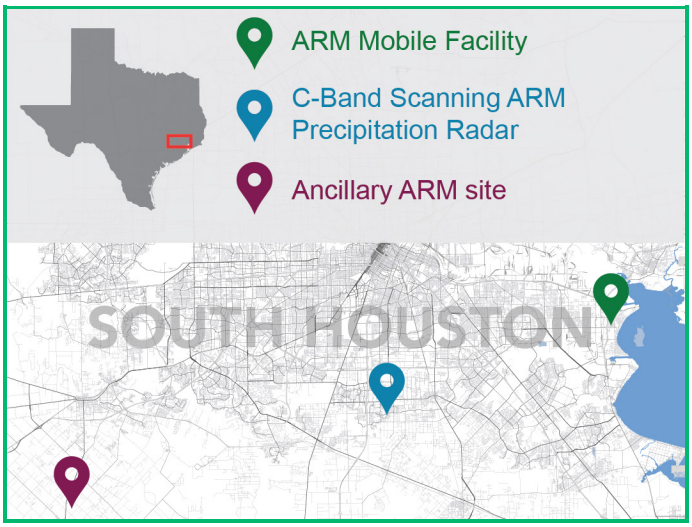
Tracking Aerosol Convection interactions ExpeRiment

Deep convective clouds, which often pack lightning and pour rain, occur nearly everywhere in the world. They are an important feature of the atmosphere, especially in storm systems that dominate the tropics and midlatitudes, but are difficult to represent in models. Researchers need more information about the processes that drive the life cycle of these clouds. For example, how do aerosols (tiny particles in the air) influence the physics of convective clouds?

The Atmospheric Radiation Measurement (ARM) user facility plans to support a field campaign aimed at finding out what happens inside deep convective clouds. The **Tracking Aerosol Convection interactions ExpeRiment (TRACER)** is scheduled to run from April 2021 to April 2022 in and around Houston, Texas. The area is unique because it commonly experiences numerous isolated convective systems and a spectrum of aerosol conditions.

ARM, a U.S. Department of Energy scientific user facility, expects to deploy one of its three mobile facilities southeast of downtown Houston and a scanning precipitation radar south of downtown.



The map shows proposed TRACER deployment locations for the ARM Mobile Facility (AMF), the C-Band Scanning ARM Precipitation Radar (CSAPR), and an ancillary ARM site (ANC).

The TRACER field campaign will study convective clouds that commonly appear over the skyline of Houston, Texas.

The second-generation C-Band Scanning ARM Precipitation Radar is expected to track convective cells during a four-month intensive operational period from June to September 2021. The cell tracking will provide important details on the evolution of precipitation microphysics in the storm updraft under a range of environmental conditions.

For the intensive operational period, ARM also plans to deploy an ancillary site southwest of Houston, in an area less affected by urban emissions than the ARM Mobile Facility site. These measurements, combined with the mobile facility data, will help researchers understand the variability of aerosols and meteorology between the onshore flow and the urban Houston area.

Science Objectives

TRACER's main objective is to provide convective cloud observations with high space and time resolution over a broad range of environmental and aerosol conditions. These observations will help better constrain high-resolution numerical model simulations, advance fundamental process-level understanding of updraft motions and microphysics, and improve the representation of deep convection in multiscale models.

Specifically, TRACER aims to provide the following field data:

- routine, high-resolution, four-dimensional (4D) radar observations of isolated convective cells spanning their full life cycle over a relatively wide range of environmental thermodynamic and aerosol conditions
- the evolution of the environment in which the convective cell initiates, grows, propagates, and decays, including the thermodynamics, winds, and aerosol characteristics
- a full annual cycle of aerosol, cloud, and radiative observations in a variably polluted, subtropical, humid coastal environment that experiences a wide range of meteorological influences.

Research Instrumentation

This campaign will use the observatory known as the first ARM Mobile Facility (AMF1), operating 24 hours a day, seven days a week. Onsite technicians monitor and maintain approximately 50 instruments to ensure that the best and most complete data set is acquired.

Key AMF1 instruments include a vertically pointing Ka-band radar and a scanning dual-frequency Ka- and X-band radar to measure properties of cloud and precipitation particles. An atmospheric emitted radiance interferometer and a microwave radiometer will provide temperature and humidity profiles. A disdrometer will provide information on precipitation (size distribution and fall speed), while an eddy correlation system will measure surface radiative and turbulent heat fluxes. An instrumentation suite for aerosols will be used to collect measurements of their cloud-nucleating properties, radiative properties, composition, and size distribution, as well as information on key trace gases.

Convective cell tracking by the C-Band Scanning ARM Precipitation Radar will provide high-resolution polarimetric and velocity observations under a range of environmental conditions. High-frequency radiosonde (weather balloon) launches will capture quickly evolving thermodynamic and kinematic conditions near convective cells—a requirement for isolating aerosol effects on clouds.

The main TRACER observatory will be the first ARM Mobile Facility, seen here during a 2018–2019 field campaign exploring the life cycles of large convective storms in north-central Argentina.

Collaborations

TRACER will use existing resources around the Houston area, including:

- a KHGX S-band radar collecting Next-Generation Radar (NEXRAD) time series data
- a network of 12 time-of-arrival lightning sensors operated and maintained by Texas A&M University
- air quality and meteorological measurements from the Texas Commission on Environmental Quality
- surface meteorological networks (National Oceanic and Atmospheric Administration [NOAA] National Weather Service and Citizen Weather Observing Program) and buoy observations (Texas Coastal Ocean Observing Network/NOAA).

The TRACER team hopes to further enhance the campaign's scientific impact with additional collaborations as the campaign planning continues.

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Additional information is available on the ARM website at www.arm.gov.