

Coast-Urban-Rural Atmospheric Gradient Experiment

Accurately representing the climate and weather variability within cities and providing well-tested representations of the impacts of urban systems on the atmospheric environment are challenges for current earth system models (ESMs). Field data for testing and developing these models are critical to addressing these limitations.

The Atmospheric Radiation Measurement (ARM) user facility will support a field campaign aimed at understanding how different surface-atmosphere interactions around a city are influencing its climate. The **Coast-Urban-Rural Atmospheric Gradient Experiment (CoURAGE)** is expected to operate from December 2024 to November 2025 in and around Baltimore, Maryland. With its aging infrastructure, growing susceptibility to heat and flooding, and ongoing issues with air and water pollution, Baltimore is characteristic of many large industrial cities in the Eastern United States.



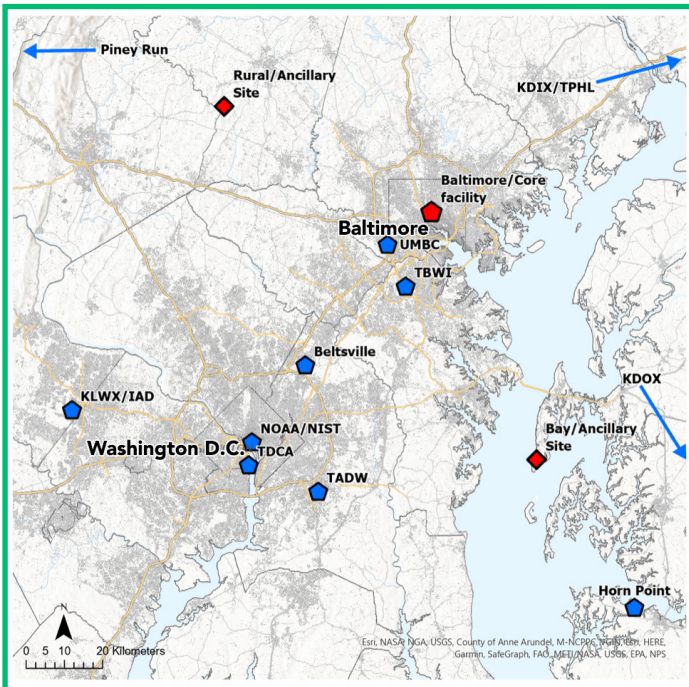
From December 2024 to November 2025, ARM plans to conduct CoURAGE in and around Baltimore, Maryland. Photo is by Larry Syverson.

ARM, a U.S. Department of Energy (DOE) Office of Science user facility, plans to deploy one of its three mobile observatories at Morgan State University's Clifton Park site in downtown Baltimore. Ancillary ARM sites are also planned for rural Maryland, northwest of the city; and to the southern end of Kent Island in Chesapeake Bay.

Data from CoURAGE will complement measurements from the Baltimore Social-Environmental Collaborative (BSEC), one of four DOE Urban Integrated Field Laboratories that will operate in cities across the United States to study urban climate change.

Science Objectives

CoURAGE's primary objective is to determine the degree to which Baltimore's atmospheric environment depends on interactive feedbacks in the atmospheric system and conditions in the city depend on the surrounding environment. CoURAGE also seeks to use observations to test current ESMs, identify weaknesses, and work toward improving climate simulations of coastal cities.



The ARM core facility and ancillary sites (red) will complement an existing regional network of atmospheric profiling and scanning radar stations (blue).

CoURAGE will aim to answer the following science questions:

- 1) What is the dependence of Baltimore's atmospheric environment (thermodynamics, cloud properties, surface radiation, aerosols and atmospheric composition, winds, precipitation) on the surrounding surface-atmosphere interactions and atmospheric environments?
- 2) What processes govern the differences in surface-atmosphere interactions that lead to significant gradients in atmospheric properties in the multiple environments surrounding Baltimore?
- 3) How well can our current numerical modeling systems reproduce these gradients and associated processes? Can we improve ESMs to simulate the Baltimore atmospheric environment with more fidelity?

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.

Researchers will use an integrated suite of atmospheric profilers and surface-based instruments to observe the interactions among clouds, the boundary layer, and atmospheric composition. Key atmospheric boundary layer and cloud profiling instruments include Doppler lidars, ceilometers, balloon-borne sounding systems, a microwave radiometer, and a vertically pointing Ka-band radar. Key surface-based instruments include laser disdrometers and an aerosol chemical speciation monitor.

Operations will include four intensive operational periods, one in each season, when the ancillary sites will be enhanced with additional balloon launches, tethered balloon system operations, and added atmospheric composition measurement activities.

Using an ARM Mobile Facility (AMF). Mobile facility deployments are determined through a user proposal process. An AMF can be deployed for stand-alone campaigns or for collaboration with interagency experiments. Scientists interested in using an AMF are encouraged to submit proposals at the following web page: www.arm.gov/research/campaign-proposal.



CoURAGE will deploy this ARM Mobile Facility, pictured during a 2021–2022 field campaign exploring convective cloud life cycles in Texas.

Collaborations

Contributions from important collaborations will support CoURAGE objectives and expand the scientific scope.

Led by Johns Hopkins University, BSEC researchers are expected to collect long-term data on the urban atmosphere and land-atmosphere interactions.

Johns Hopkins University and the University at Albany will deploy mobile laboratories within the city of Baltimore to monitor trace gases and track aerosol particle size distribution.

An existing long-term observatory operated in Beltsville, Maryland, by Howard University and the Maryland Department of the Environment will measure air that is carried into Baltimore by winds traveling from the southwest near Washington, D.C.

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

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CoURAGE Web Page

