LASSO: Tying LES Modeling and ARM Data Together for Atmospheric Science

A key activity for the Atmospheric Radiation Measurement (ARM) user facility is tying together observational data and large-eddy simulation (LES) modeling to support the study of atmospheric processes, improvement of observational retrievals, and parameterizations of clouds, aerosols, and radiation in earth system models. The LES ARM Symbiotic Simulation and Observation (LASSO) activity currently provides a library of LES output encompassing both shallow and deep convection to complement ARM's observations.

Since data collection began in 1992, ARM has been a key component of the U.S. Department of Energy's (DOE) efforts to better understand and predict earth system processes to develop sustainable solutions to the nation's energy and environmental challenges. ARM is a world leader in providing unprecedented, continuous observations of cloud and aerosol properties and their impacts on Earth's energy balance—data that have proved invaluable for understanding the atmosphere and improving the predictive capabilities of earth system models.

A powerful mechanism for relating ARM data to earth system models is to run a high-resolution model over an ARM observatory, linking the local scale of the ARM measurements with the much larger scale of the earth system model. In 2015, ARM began development of LASSO to routinely generate high-resolution simulations for the research community. LASSO is now a mature capability, providing an extensive LES library supporting model development and process studies.

A Growing Library of Simulations

LASSO enhances ARM observations by using LES modeling to provide context and a self-consistent representation of the atmosphere surrounding the observed location, connecting processes, and facilitating improved understanding. The project has resulted in an ever-growing library of freely available simulations that can be used for process analyses and the development of model parameterizations and remote-sensing retrievals.

The CACTI field campaign in the Sierras de Córdoba mountain range of north-central Argentina began in October 2018 and ended in April 2019. This region experiences some of the world's most intense thunderstorms.

The LASSO library currently provides LES modeling for two meteorological regimes: continental shallow convection over ARM's Southern Great Plains atmospheric observatory in Oklahoma and deep convection during the Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign in Argentina.

Maritime shallow convection at ARM's Eastern North Atlantic observatory in the Azores is under development, and additional regimes are under consideration.

LASSO for Deep Convection

The deep convection LASSO scenario focuses on convective initiation near the ARM Mobile Facility deployed at Córdoba, Argentina, during CACTI in 2018 and 2019. Available simulations include ensembles of mesoscale simulations with grid spacings down to 2.5 kilometers for 20 case dates. A subset of dates are further refined using LES down to 100-meter grid spacing. These LES are cutting-edge simulations with domain widths over 200 kilometers capturing multiple hours of storm evolution. The complementary mesoscale ensembles provide a measure of the sensitivity of storm development to the background, environmental conditions.

LASSO for Shallow Convection

LASSO produced ensemble, high-resolution simulations at ARM's Southern Great Plains observatory for five seasons (2015–2019). The released data bundles of shallow convection amount to 95 case days, which contain a suite of relevant observations combined with the associated LES output and evaluation skill scores. Researchers have used these data for multiple types of research, such as for optimizing radar scan strategies, extending the theory of cloud distributions, and understanding vertical cloud overlap and the impacts of three-dimensional radiative transfer on cloud simulations.

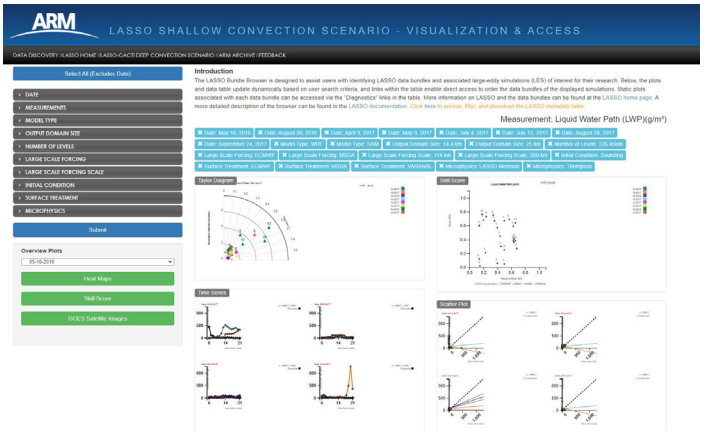
Community Input on LASSO

To ensure that this DOE project meets researcher needs, community input is sought regarding LASSO's value and potential enhancements that would make it more valuable.

Questions about how to use LASSO, suggestions, and feedback can be sent to ***lasso@arm.gov***. Researchers can also engage with the LASSO team through the Discourse forum: ***discourse.arm.gov/c/lasso/5***.

More information about the CACTI scenario and other expansion possibilities is available in the LASSO Expansion Workshop report. The LASSO team is working through development of a scenario focused on maritime boundary-layer clouds from the 2017–2018 Aerosol and Cloud Experiments in the Eastern North Atlantic (ACE-ENA) campaign. ARM and the LASSO team will continue to engage with the community to enable the implementation of these cases and other meteorological regimes.

To be included in LASSO project email updates, sign up for the LASSO information email list at ***http://eepurl.com/bCS8s5***



LASSO's Bundle Browser offers scientists an easy way to search for the data most relevant to their work. Shown here is the version for shallow convection.

Additional Information

- LASSO Website
  www.arm.gov/capabilities/modeling/lasso
- LASSO Shallow Convection Bundle Browser
  adc.arm.gov/lassobrowser
- LASSO-CACTI Deep Convection Bundle Browser
  adc.arm.gov/lasso/#/cacti
- LASSO Expansion Workshop Report
  www.arm.gov/publications/programdocs/doe-sc-arm-19-023.pdf
- ARM LASSO News
  bit.ly/ARMLASSO
- ARM Decadal Vision
  www.arm.gov/publications/programdocs/doe-sc-arm-20-014.pdf

For more information, contact:

Jim Mather
ARM Director
jim.mather@pnnl.gov

William Gustafson
LASSO Lead
william.gustafson@pnnl.gov

Andrew Vogelmann
LASSO Co-lead
vogelmann@bnl.gov

Sally McFarlane
DOE Program Manager
ARM User Facility
sally.mcfarlane@science.doe.gov

DOE/SC-ARM-15-073
Revised September 2023

U.S. DEPARTMENT OF ENERGY | Office of Science

ARM is funded through the U.S. Department of Energy's Office of Science.
Additional information is available on the ARM website at www.arm.gov.