



AEED Atmospheric, Earth & Energy Science

Innovative Science Above, On, and Below the Planet's Surface

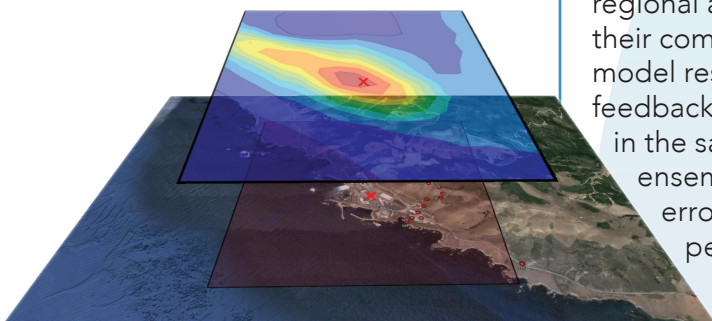
Lawrence Livermore National Laboratory's (LLNL's) missions in national security, energy security, and fundamental science require robust, multidisciplinary research and development in atmospheric, Earth, and energy sciences. Our researchers utilize world-class scientific capabilities and modern high-performance computing facilities to support Laboratory programs that focus on these missions. Key areas of research include seismology, geophysics, geomechanics, geochemistry, atmospheric dispersion, climate modeling and model intercomparison, climate change detection and attribution, and the hydrological and carbon cycles. We also develop experimental and computational capabilities to better understand the complex interactions among energy production, energy utilization, and the environment. LLNL's Atmospheric, Earth, and Energy Science Division continually innovates to make the world safer, the environment cleaner, and our energy resources more sustainable.

Everything we do supports Laboratory missions in:

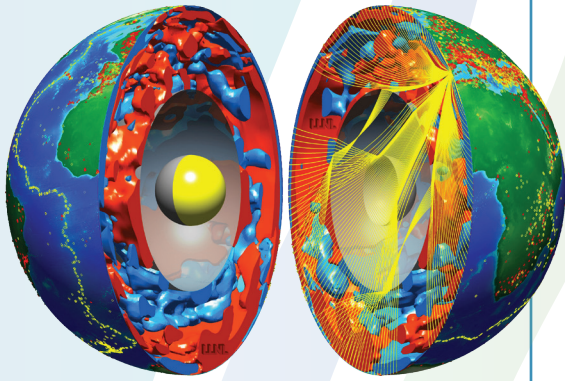
- Carbon capture and storage
- Climate change
- Nuclear nonproliferation
- Radiological emergency response
- Clean and secure energy
- Infrastructure security

ATMOSPHERIC SCIENCE

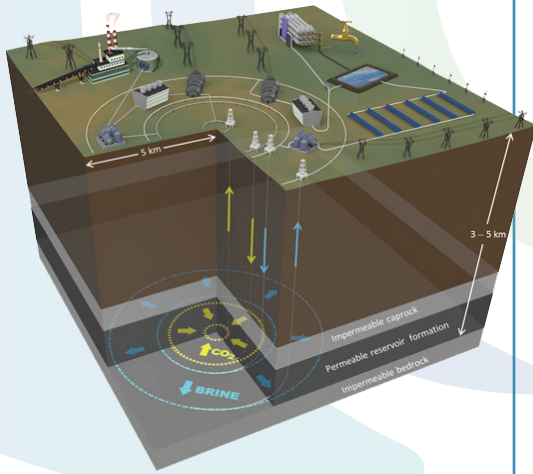
LLNL's atmospheric science research leverages high-performance computing to enhance national security, energy security, and environmental security missions. With expertise in local-to-global scale behavior of the atmosphere, we incorporate state-of-the-science simulation capabilities into atmospheric models. These models are used to determine real-time health effects from radiological accidents, estimate the performance of renewable energy systems, and predict decadal-to-century changes in regional and global climates. We extensively evaluate models and their components with rigorous and quantitative comparisons of model results to observations, with an emphasis on cloud-climate feedbacks and the detection and attribution of climate change in the satellite and surface climate records. We also employ ensemble and inversion techniques to estimate the prediction error and quantify the uncertainty of our calculations against petabyte global datasets.



The source location for a tracer release at Diablo Canyon Nuclear Power Plant in California is derived from measurement data using inverse statistical and probabilistic analysis methods.



To advance seismic event monitoring capabilities, LLNL developed a global-scale model of seismic velocities in Earth's crust and mantle with regional-scale details.



This integrated "underground battery" system combines storage of energy and disposal of carbon dioxide in an underground reservoir system.

EARTH SCIENCE

Earth scientists at LLNL study a range of research areas in support of energy, environmental, and national security missions. Our expertise includes seismic and geophysical monitoring, earthquake and explosive source physics, hydrology and reactive transport modeling and experimentation, and multi-scale multi-physics simulation of subsurface processes. We explore long-term, sustainable ways to dispose of excess carbon dioxide through subsurface and synthetic methods of carbon capture utilization and sequestration. Using novel algorithms on the world's fastest supercomputers, we deliver high-fidelity, three-dimensional predictions to inform industrial partners in risk assessment and optimization of resource extraction. These high-performance computing activities advance our capabilities in managing seismic databases and complex data analysis. We also address coupled hydro-chemical-thermal-mechanical phenomena relevant to both natural and engineered applications.

ENERGY

LLNL's national security mission includes enhancing energy security through expanded supply, increased efficiency, and risk mitigation. We perform extensive simulation and analyses to better understand complex energy systems. Our scientists tackle a diverse portfolio of energy projects including wind power forecasting, the energy-water nexus, carbon capture and sequestration, geothermal reservoir management, subsurface energy storage, advanced nuclear fuel cycle studies, and resource utilization analyses. We are helping meet increasing energy demand with minimal environmental impact. Our partners include Department of Energy Offices and Programs (Wind Technologies Office, Office of Energy Policy and System Analysis, Preventative Nuclear Detection Program, Critical Materials Institute), the State of California, and academic and industrial collaborators.